"He Is Not Here," Or Is He?
A Statistical Analysis of the Claims Made in *The Lost Tomb of Jesus*

By Jay Cost and Randy Ingermanson[1]

Introduction

In March, 2007 Emmy-winning filmmaker Simcha Jacobovici presented a documentary, *The Lost Tomb of Jesus,* that proffered a startling thesis: Jesus of Nazareth, whom most Christians believe rose bodily from the dead, was actually buried in a tomb in the present-day East Talpiot neighborhood of Jerusalem.[2]

As evidence for the thesis, Jacobovici enlisted the aid of University of Toronto professor of statistics Andrey Feuerverger, who, Jacobovici claimed, calculated the odds that this is the Jesus family tomb at 600 to 1.[3]

In the present paper we offer a critique of this statistic and an alternative estimate. We argue that Bayes' Theorem is the optimal way to calculate the likelihood that this tomb belonged to Jesus of Nazareth. We further argue that the estimate derived from Bayes' Theorem is fairly insensitive to a series of assumptions that can be altered as the vital debate among historians and archaeologists requires. Finally, making what we believe to be a set of reasonable assumptions, we offer a series of estimates of the likelihood that the Talpiot tomb belonged to Jesus of Nazareth.

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[2] See Simcha Jacobovici. *The Lost Tomb of Jesus*. Discovery Network. First Aired March 4, 2007.

[3] In the aftermath of the documentary's release, Jacobovici and the Discovery Channel modified their interpretation of Feuerverger's mathematical computations. It is unclear to us exactly what Jacobovici now believes that Feuerverger's number demonstrates. However, it is nevertheless clear that he believes now, as he did before the updates made to the Discovery Channel's documentation, that Feuerverger's number provides *some* analytical "purchase" on whose tomb was discovered at the Talpiot site. In other words, while we are not sure the exact nature of the inference that Jacobovici draws about the tomb from the number, we *are* sure that he is drawing some kind of inference about the tomb ownership from the number. We disagree even on this minimal point. We think that this number is insufficient for *any* inference about the tomb, and we will justify this disagreement in the course of this essay.

The Talpiot Discovery and the Documentary's Argument

In 1980, the Israeli Antiquities Authority excavated a tomb in East Talpiot, a Jerusalem neighborhood. Within the tomb, archaeologists discovered ten ossuaries, or bone boxes used to intern the deceased between the first century BCE and first century CE.[4] Six of the ossuaries had names inscribed upon them – five in Aramaic and one in Greek. The Aramaic inscriptions, when translated into English, were "Judah son of Jesus," "Jesus son of Joseph," "Jose" (a diminutive of "Joseph"), "Mary" and "Matthew." Kloner (1996), following Rahmani (1994), translates the Greek inscription as "Mariamne [also called] Mara."[5]

In the documentary *The Lost Tomb of Jesus*, Jacobovici argues that four of these names correspond with the family of Jesus of Nazareth. "Jesus son of Joseph" might have been a way to address Jesus of Nazareth. Further, Jesus of Nazareth had a brother named Jose and a mother named Mary. Jacobovici further speculates that Kloner (1996) and Rahmani (1994) have mistranslated the Greek inscription. He asserts that the correct translation is "Mary [also called] the Master." He goes on to argue, using the 4th century apocryphal document called *The Acts of Philip*, that this is a name by which Mary Magdalene might have been known.

It is from this cluster of names that Professor Feuerverger derives his figure. To date, Professor Feuerverger has not submitted a formal paper for either public viewing or scholarly vetting.[6] Accordingly, his statistical intuitions must be gleaned from the popular consumption book, *The Jesus Family Tomb*,[7] and the documentary's website.[8] The formula offered in the latter is as follows:

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[4] See Craig Evans. *Jesus and the Ossuaries*. Waco, TX: Baylor University Press, 2003.

[5] See Amos Kloner. "A Tomb with Inscribed Ossuaries in East Talpiyot, Jerusalem," *Atiquot* 29, 1996, and L.Y. Rahmani. *A Catalogue of Jewish Ossuaries in the Collections of the State of Israel*. Israel: Israeli Antiquities Authority / Israel Academy of Sciences and Humanities, 1994.

[6] Currently, Feuerverger has made an explanation of some of the assumptions inherent to his calculation available on line. See Andrey Feuerverger. "The Tomb Calculation, Letter to Statistical Colleagues. March 12, 2007." http://fisher.utstat.toronto.edu/andrey/OfficeHrs.txt. Accessed March 26, 2007. Note that Jacobovici and Pellegrino (2007) indicate that Feuerverger *has* submitted a paper to scholarly review, but the above-referenced letter from Feuerverger indicates that this is not the case. Personal correspondence between Feuerverger and one of the authors confirmed that Feuerverger's letter is correct on this point.

[7] See Simcha Jacobovici and Charles Pellegrino. *The Jesus Family Tomb*. San Francisco: HarperCollins, 2007.

[8] See "The Lost Tomb of Jesus: The Discovery Channel." http://dsc.discovery.com/convergence/tomb/tomb.html. Accessed March 26, 2007.

Initial Computation					
Jesus Son of Joseph: 1 in 190	Mariamne: 1 in 160	Matia: 1 in 40	Yose: 1 in 20	Maria: 1 in 4	= 1 in 97,280,000
Second Computation (Matthew Eliminated)					
Jesus Son of Joseph: 1 in 190	Mariamne: 1 in 160	Yose: 1 in 20	Maria: 1 in 4		= 1 in 2,400,000
Third Computation (Unintentional Historical Biases Factored In)					
2,400,00 / 4					= 1 in 600,000
Fourth Computation (All Potential Tombs Factored In)					
600,000 / 1,000					*= 1 in 600 = "Probability Factor"*

Critique of the Statistical Method

The above method, as we are able to interpret it, suffers from several important defects that prevent any valid inference about the family in the tomb from being drawn. These defects can be grouped into two types: theoretical and computational.

Theoretical Defects

This method generally lacks probative value. That is, the "probability factor" does not speak to the likelihood that Jesus of Nazareth was buried at this tomb. It is simply an estimate of the probability of finding these four names – "Jesus son of Joseph," "Mariamne," "Jose" and "Maria" – in all tombs with exactly four inscribed names. It is does not speak to whether this family is actually the family of Jesus of Nazareth. This is because it fails to consider two important factors.

It does not consider the unlikelihood of ever finding Jesus of Nazareth's tomb in the first place. It might be a unique occurrence to find these four names, but the uniqueness of this occurrence must be understood in the context of the uniqueness of finding Jesus of Nazareth at all. For instance, if there were a 1 in 1 billion chance that we would find Jesus of Nazareth's ossuary, the probative value of the unadjusted probability in the above table, which shows a 1 in 2.4 million likelihood, would be severely diminished. Thus, this other probability must be taken into account before *any inferences* can be drawn. To fail to do so is to commit what is known as the *prosecutor's fallacy*. The unlikelihood of finding the particular evidence that has been found must be weighed against the unlikelihood of making the match that the documentarians wish to make.

Second, it assumes that there is no doubt that Jesus of Nazareth – if he was buried in a tomb – would certainly be buried with these individuals. The implication here is that this is a "unique" match with the family of Jesus of Nazareth. However, this hypothesis is underdetermined. Even if we accept the uniqueness of the names, and there is good reason not to, there are reasons to expect Jesus of Nazareth to be buried with *another* cluster of names. This estimation, further, cannot be taken in the context of the four matches. It must, rather, be taken in the context of all *six* matches – for this "Jesus son of Joseph" was not interned with three other known people. He was interned with five. Thus, we should inquire whether there is reason to expect that Jesus of Nazareth would be interned with these five names.

Computational Defects

The calculation itself also suffers from four computational problems.

First, there are six inscribed ossuaries in the tomb. If the intention is to discover the probability of finding these four names in a given tomb of this type, it should be calculated with a mind to the number of inscribed ossuaries in the tomb and not to the number of "matches" that one wishes to make. For instance, if there are six inscribed ossuaries, the chances of finding these four names should be calculated not as the chance of finding the four names in four attempts, as is the case here, but of finding these four names in six attempts.

Second, the factor that "adjust[s] for unintentional biases in the historical record" seems to be *ad hoc*. This, it is explained in Jacobovici and Pellegrino (2007), is intended to account for the family members who might have been placed at the tomb but are in fact not there – namely the brothers James, Simon and Jude. However, it is unclear to us why a factor of four is sufficient for dealing with the "absences" from the tomb. It seems more appropriate to include the factor we mentioned above – an evaluation of the likelihood that Jesus of Nazareth would be interned with *this* particular cluster of names. Hopefully, at a future date Professor Feuerverger will have the opportunity to clarify his justification.

Third, the documentarians hypothesize that Mary Magdalene was interned in one of the ossuaries, and that "Mariamne [also called] Mara" is a mistranslation that, when corrected, points toward her. However, they do not offer a convincing argument as to why this is *expected* to be the case. At best, they provide a *potential* connection between the two.[9] This connection should be critically evaluated before the name "Mariamne [also known as] Mara" is included in the computation. Absent this inquiry, the statistical computation should be limited to the three known matches between the tomb and Jesus of Nazareth's family. Including "Mary Magdalene" in the statistical analysis heavily biases the probability estimate toward the hypothesis.

Fourth, the computation fails to account for the potential bias that occurs with the consideration of the name "Jose," which Jacobovici takes as a rare and highly significant reference to Jesus of Nazareth's brother. It fails to consider that "Jose" has been found *given the discovery of a reference to "Joseph."* It is reasonable to believe that "Jesus son of Joseph" and "Jose" might not be independent events – namely, that "Joseph" might have generally been a family name. Accordingly, when a Joseph is found in a family, one is more likely to find another Joseph, or a person with a variant of the name, such as "Jose." Thus, we should expect $P(Jose|Joseph) > P(Jose)$. Unfortunately, the historical record is not sufficiently detailed to offer conditional probabilities such as the one that we have in mind. However, this is not to say that the computation's incorporation of "Jose" is optimal. While it might be impossible to estimate the precise difference be-

[9] For this argument, they rely upon the research of François Bovon. However, in a recent article, Bovon argues: "I do not believe that Mariamne is the real name of Mary of Magdalene. Mariamne is, besides Maria or Mariam, a possible Greek equivalent, attested by Josephus, Origen, and the *Acts of Philip*, for the Semitic Myriam." See François Bovon. "The Tomb of Jesus." *The Society of Biblical Literature Forum*. http://sbl-site.org/Article.aspx?ArticleId=656. Accessed March 26, 2007.

tween *P(Jose|Joseph)* and *P(Jose)*, it seems intuitive to expect that the former is greater than the latter. Thus, Jacobovici and Feuerverger are likely wrong to take the name "Jose" to occur with less frequency than the name "Joseph" (which they do). They should, instead, expect a "Jose" or some variant to occur in a tomb like this, i.e. one that was used by a family known to have a "Joseph" within it, with a greater likelihood than a "Joseph" would in the general population.

Even with these critiques, the above figure represents an important step in calculating the probability that this tomb belongs to Jesus of Nazareth. Jacobovici and Feuerverger are to be credited for astutely recognizing that the other names in the tomb are the key components in determining whether the Talpiot tomb once held the remains of Jesus of Nazareth. Building upon their intuition, we propose a different, more comprehensive approach than they have adopted.

Bayes' Theorem and the Jesus Tomb

Introduction

We propose the use of Bayes' Theorem to evaluate the likelihood that this tomb belongs to Jesus of Nazareth. Indeed, it is our intuition that Bayes' Theorem offers the most direct way to answer the question at hand. We also believe that Jacobovici's argument is fundamentally Bayesian. Jacobovici is interested in the extent to which the other names in the tomb provide a clue to the person interned in the "Jesus son of Joseph" ossuary. In other words, his endeavor is to find a conditional probability: given the other names in the tomb, what is the likelihood that Jesus of Nazareth is interned in the "Jesus son of Joseph" ossuary, what we define as *P(J|T)*. Meanwhile, it is Jacobovici's intuition that the Talpiot tomb provides a close match with *what we would expect in Jesus of Nazareth's tomb*. That is, he believes that what we define as *P(T|J)* is very large – i.e., if we were assuredly to find Jesus of Nazareth's tomb, we would expect many of these names within it.

What Jacobovici has done, then, is define one conditional probability, *P(J|T),* in terms of another, *P(T|J)*. This is a Bayesian argument. Unfortunately, as the last section makes clear,

Feuerverger's statistical analysis does not speak to this. It suffers from two theoretical problems:
(i) any inferences drawn from his number will run afoul of the prosecutor's fallacy;
(ii) it implicitly assumes an artificially high value of $P(T|J)$.
What is required, then, is a reformulation and formalization of what we take to be Jacobovici's accurate intuitions.

Statement of the Problem

A tomb has been found in East Talpiot, Jerusalem, containing ten ossuaries. Six of these were inscribed with names, while four were not. The excavating archaeologists estimated that the tomb might have held up to 35 bodies. This was not based on any count of bones within the tomb. Rather, it was an estimate based on many similar tombs around Jerusalem dating from the same era, the first century.[10]

Two of the ossuaries are special and indicate a rudimentary family tree. One is inscribed "Judah son of Jesus" and the other is inscribed "Jesus son of Joseph." While there is no proof that the "Jesus" in these two inscriptions is the same man, that is the general assumption, since a tomb like this generally contained extended families over several generations.

The immediate question to ask is whether the ossuary inscribed "Jesus son of Joseph" might have contained the bones of Jesus of Nazareth. The ossuary dates to the first century and the tomb lies within a few miles of the crucifixion site of Jesus of Nazareth. What is the probability that Jesus of Nazareth might be the Jesus of the tomb?

If that were all the information we had, then the answer would be fairly easy to compute. Suppose there were N_J men in Jerusalem named "Jesus son of Joseph." The probability of choosing any one of these at random is clearly $1/N_J$.

[10] See Kloner (1996).

We note that Jesus of Nazareth is *not* a randomly selected “Jesus son of Joseph” from ancient Jerusalem. We have more information about him than we do about the other men named “Jesus son of Joseph.”
Most scholars accept the New Testament account that Jesus was buried immediately after his crucifixion in a tomb owned by Joseph of Arimathea, roughly three miles from the East Talpiot location of the alleged “Jesus family tomb.” Nobody believes Jesus of Nazareth is still in this original resting place.

Christians generally believe that Jesus was physically resurrected about a day and a half after his death and that he eventually ascended to heaven. If that is not the case, then he was instead re-buried elsewhere (perhaps a tomb such as this, or a common burial pit, or something else). Conceivably, he could have been transported some three miles away to the East Talpiot tomb, but that is not a sure thing. But neither is it a sure thing that he was not.

The question of whether Jesus ascended to heaven is a faith-question, which will be answered differently by different people. The question of whether Jesus might have been transported three miles to East Talpiot for reburial is a historical question, which will be answered differently by different historians. In either case, there is a subjective element.

This appears to put us at an impasse. But does it really? We argue that it does not. The subjective element introduces uncertainty into the calculations, but science has well-defined ways for dealing with numerical uncertainties. Thus, while we might not be capable of identifying an expected probability value, we might nevertheless be able to identify the range of values that this probability might take.

There are several points in this calculation at which we will run into “judgment calls” that depend on subjective elements. We will encapsulate each of these points in a “fuzzy factor” that is strictly bounded. We will then carry out the calculations and show that the final range of probabilities is still bounded. We will now define the first “fuzzy factor.”

Define F_1 = "the probability that the body of Jesus of Nazareth was transported to a tomb of the type found at East Talpiot and featured in the documentary *The Lost Tomb of Jesus*."

Obviously, F_1 is a subjective factor. Those who believe with certainty in a physical resurrection and ascension of Jesus will assign F_1 a value of zero. Those who believe with certainty that Jesus was reburied in a trench grave near the site of the crucifixion will likewise assign F_1 a value of 0. Those who are willing to consider the possibility that he was transferred a few miles away, and that he might have ended up in a family tomb, will assign F_1 a non-zero value. Those who consider the tomb a bad demographic or socio-political "match" for Jesus of Nazareth's family – for instance because the tomb might be a "middle class" tomb, etc – would assign a low non-zero value. Those who see the Talpiot tomb as a good potential match would assign it a higher number. F_1 cannot be less than 0 or greater than 1, since it is a probability. So F_1 is a bounded parameter, and it is likely to have only limited effect on our calculations. We can run calculations with different values of F_1 when we complete our analysis to see what is the range of effects it can have.

We asked earlier for a first estimate of the probability that Jesus of Nazareth is buried in the East Talpiot tomb. We need some notation. Define:

J = The event that Jesus of Nazareth was buried in the East Talpiot tomb.

~J = The event that Jesus of Nazareth was *not* buried in the East Talpiot tomb.

P(J) = The probability that Jesus of Nazareth was buried in this tomb.

P(~J) = The probability that Jesus of Nazareth was *not* buried in this tomb.

Obviously, since *J* and *~J* are exclusive events, *P(J)* and *P(~J)* add up to 1.

Then we have the following naïve estimates of *P(J)* and *P(~J):*

$$P(J) = \frac{F_1}{N_J}$$

$$P(\sim J) = 1 - P(J)$$

We note that N_J has been estimated by different scholars to be anywhere from a few hundred up to about 1,000.

If this were all the information we had, then the tomb would not be interesting since *P(J)* is very small. However, the tomb also contains ossuaries bearing the names "Mary," "Mary," "Matthew," and "Jose." We know that Mary was the name of the mother of Jesus of Nazareth and the name of several other women in the close circle of Jesus (including Mary Magdalene, Mary of Bethany, and probably others). Furthermore, one disciple of Jesus was named Matthew and one of his brothers was named Jose. These factors tend to strengthen the case that the tomb might belong to Jesus of Nazareth.

However, there is also some counter-evidence. One ossuary in the tomb bears the name "Judah son of Jesus." No record tells us that Jesus of Nazareth had any offspring at all, much less a son named Judah. We should note that no historical records explicitly deny that Jesus had children, but we would expect to have heard of progeny if they existed. Three leaders in the earliest Jesus community were his brothers James and Judah and his cousin Simon. This indicates that the family of Jesus played an important role in the early community. A son would have played a key role in this community had he existed. If Jesus had a son, history is stunningly silent about it, for no apparent reason.

So the problem then is the following: In light of these additional five inscriptions, how does the naïve estimate *P(J)* change? Will the "pro" evidence outweigh the "con" evidence?

We will use a few simple techniques from statistics and probability theory to estimate a revised probability. A key element will be Bayes' Theorem. We will briefly review Bayes' Theorem next.

Bayes' Theorem

In probability theory, one often needs to compute a conditional probability of one event, given that another has occurred. This allows one to make inferences based on partial information.
As an example, suppose two dice are thrown. The odds of rolling a 12 are quite low: 1/36.
However, if we are given information on the state of one of the dice, we can make a revised es-

timate. If we are told that one of the two dice came up a six, then the odds of having rolled a 12 are now revised to 1/6. However, if we are told that one of the dice came up a three, then the odds of having rolled a 12 are now revised to 0.

Let E_1 and E_2 be two events. We are interested in the probability that E_1 has occurred, given that E_2 has occurred. This is called the conditional probability $P(E_1 | E_2)$ and is defined to be:

$$P(E_1 | E_2) = \frac{P(E_1 \& E_2)}{P(E_2)}$$

One formulation of Bayes' Theorem then follows immediately:

$$P(E_1 | E_2)P(E_2) = P(E_1 \& E_2) = P(E_2 | E_1)P(E_1)$$

We can rewrite this as:

$$P(E_1 | E_2) = \frac{P(E_2 | E_1)P(E_1)}{P(E_2)}$$

This is a powerful form of the theorem, but we will expand the denominator by noting that either E_1 will occur or it will not. So it is easy to prove that

$$P(E_2) = P(E_2 | E_1)P(E_1) + P(E_2 | \sim E_1)P(\sim E_1)$$

Then we get the fairly complicated-looking equation:

$$P(E_1 | E_2) = \frac{P(E_2 | E_1)P(E_1)}{P(E_2 | E_1)P(E_1) + P(E_2 | \sim E_1)P(\sim E_1)}$$

This is useful when we already have a naïve estimate $P(E_1)$ and we want to improve it in view of the observation of a second event E_2. Bayes' Theorem tells us how to make this improvement.

In the previous section, we made a naïve estimate $P(J)$ and we then asked how to improve this estimate based on a set of other observations from the tomb. We will denote the collection of these other observations by the event T:

T = "All the rest of the information about the other five ossuaries".

We are interested to know how this new information *T* changes our naïve estimate *P(J)*. In other words, we want to know the probability that Jesus of Nazareth is *really* the Jesus of the tomb, *given all the other information we have from the other ossuaries*. That is, we want $P(J|T)$. Bayes' Theorem then tells us that:

$$P(J \mid T) = \frac{P(T \mid J)P(J)}{P(T \mid J)P(J) + P(T \mid \sim J)P(\sim J)}$$

Bayes' Theorem takes a bit of getting used to, but it corresponds to Jacobovici's and our intuition. For example, if Jesus of Nazareth were really buried in this family tomb, we would expect the other names in the tomb to correspond to his family members. That is, we would expect $P(T|J)$ to be rather high. Whereas if Jesus of Nazareth were *not* buried in the tomb, we would expect the names in the tomb *not* to correspond well with his family members. That is, we would expect $P(T|\sim J)$ to be rather low.

Bayes' Theorem tells us how to weigh the two cases against each other to make the best decision we can in light of the information we have. If new information were to come to light, that would change the calculation.

We have already shown in principle how to compute *P(J)* – the initial naïve estimate that Jesus of Nazareth is in the tomb. From that, we immediately get $P(\sim J)$. So it remains only to compute the two conditional probabilities $P(T|J)$ and $P(T|\sim J)$. These are not hard, and we will spend the bulk of this article estimating these.

First, however, there are a few preliminary issues to work through.

Preliminaries to P(T|J) *and* P(T|~J)

First, we will deal with the issue of the ossuary "Judah son of Jesus." If the Jesus of the tomb were some randomly chosen man on the street, he would have a high probability of having a son. Most Jewish men of the period were married and did their best to obey the commandment to be fruitful and multiply. We do not know the exact probability that any given man would have a son, but it is likely to be near 1.

That is not the case for Jesus of Nazareth. In all of history, nobody seems to have ever postulated that Jesus had a son. Dan Brown, in the *DaVinci Code*, followed a long and hazy tradition that postulates a daughter. Did Jesus of Nazareth have a son? We do not know for sure. What we can say is that he *might conceivably* have had a son but that he is *not more likely* than a randomly chosen man of Jerusalem to have had a son. So we can define another "fuzzy factor" here to incorporate this range of possibilities. Define F_2 as follows:

F_2 = the relative probability that Jesus of Nazareth had a son

By "relative probability" we mean the ratio of the probability that Jesus had a son to the probability that any other man of Jerusalem had a son. We expect F_2 to be between 0 and 1. Different historians will assign different values to F_2. We will see at the end of this calculation whether it makes much difference what value you assign to F_2.

We also define $P_{son-Judah}$ to be the absolute probability that a randomly chosen man of Jerusalem would have had a son named Judah.

Then, by definition, the probability that Jesus of Nazareth had a son named Judah is $F_2 P_{son-Judah}$. We will never actually need to compute $P_{son-Judah}$. It will factor out of our equations completely, leaving us with only the fuzzy factor F_2, which is nicely bounded between 0 and 1.

It is worth defining exactly what we mean by the event *T*. What we really care about is the set of all possible events *like* the set of names observed in the tomb. That is, we want to consider all sets of names that would generate the same level of surprise. We have already dealt with the surprises of two of the ossuaries. There remain four, containing two women and two men.

What is surprising is that two of these had the names of members of the immediate family of Jesus. We found a Mary and we found a Jose. Each of those coincides with names of known members of the family of Jesus. We also found a second Mary, who is known by DNA analysis *not* to be a member of the immediate family of Jesus. We also found a Matthew, who is *not* in the known immediate family of Jesus.

If we opened a random tomb in Jerusalem and found two women and two men, what are the odds that at least one of the women would be a Mary and at least one of the men would have the name of a brother of Jesus? That is the question that $P(T|\sim J)$ will answer.

Likewise, if we had opened the *actual tomb of the family of Jesus* and found the names of two women and two men, we must also ask what are the odds that at least one of the women would be a Mary and at least one of the men would have the name of a brother of Jesus. Neither of these is a sure thing, even in the family tomb of Jesus. That is the question that $P(T|J)$ will answer.

In order to answer these questions, we need to know the probability of drawing the names of close family members of Jesus if we choose people from ancient Jerusalem at random. We need census data, and we do not have it. But we do have two surveys of names from Israeli scholars, Rachel Hachlili and Tal Ilan.[11] Their numbers do not agree perfectly, but they are reasonably close to each other.

In the following table, we summarize the relevant data. Note that names took many forms in ancient Israel. We consider all variant forms to be essentially the same. So the Hebrew/Aramaic/Greek names Miriam, Mariam, Maria, Mariame, Mariamme, Mariamne, Mariamene, Mariamenon, etc., all count as Mary. Likewise, the variant forms Yosef, Yehosef, Yosi, Yoseh, Yosah, etc., all count as Joseph.

We will also assume that the probability of finding a "Jesus son of Joseph" is obtained by multiplying the probability of finding a "Jesus" by the probability of finding a "Joseph". Note that Jesus had four brothers, James, Simon, Judah, and Jose. Jose is a variant form of Joseph.

[11] See Rachel Hachlili. "Names and Nicknames of Jews in Second Temple Times," *Eretz* Israel 17, 1984, and Tal Ilan. *Lexicon of Jewish Names in Late Antiquity: Part 1, Palestine 330 BCE-200 CE*. Tubingen, Germany: Mohr Siebeck, 2002.

Here are the probabilities that we will need:

Name	Probability (Hachlili)	Probability (Ilan)
Jesus	0.09	0.0411
Joseph	0.14	0.0921
Jesus son of Joseph	**0.0126**	**0.0038**
Simon	0.21	0.1024
Judah	0.10	0.0713
James	0.02	0.0179
Joseph	0.14	0.0921
Any Brother of Jesus	**0.47**	**0.2837**
Mary	**0.214**	**0.254**

Since we have two choices for the probability distributions of names, we will need to run our calculations twice, once for Dr. Hachlili's numbers and once for Dr. Ilan's numbers.

We can now estimate the number of men in Jerusalem who might be named "Jesus son of Joseph." Suppose there were N people in Jerusalem, and suppose the practice of burial in ossuaries continued for g generations. The practice went on for about 90 years, so g will be more than 1 but less than 3. Since half the inhabitants of Jerusalem were males, we estimate the number of men named "Jesus son of Joseph" to be:

$$N_J = \frac{1}{2} N g P_{Jesus} P_{Joseph}$$

Estimating $N = 80{,}000$, $g = 2$, we find a value roughly between 300 and 1000.

We are now ready to compute $P(T|J)$ and $P(T|{\sim}J)$. The second of these is a bit easier to compute, so we will do it first.

Computing P(T|~J)

If we know for sure that the ossuary labeled "Jesus son of Joseph" did *not* contain Jesus of Nazareth, what are the odds of observing the other five ossuaries in the tomb?

That is quite easy to compute. There are three factors:

1) The probability of the "Judah son of Jesus" ossuary, which is $P_{son-Judah}$
2) The probability of finding at least one "Mary" ossuary out of two ossuaries containing randomly chosen women.
3) The probability of finding at least one ossuary with the name of a brother of Jesus, out of two ossuaries containing randomly chosen men.

Define P_{Mary} to be the probability of a randomly chosen woman being named Mary. We can estimate this using either Rachel Hachlili's data or Tal Ilan's data, given in the table above. Then the probability of a randomly chosen woman *not* being a Mary is $1 - P_{Mary}$. Likewise, the probability that *neither* of two randomly chosen women will be a Mary is $(1 - P_{Mary})^2$. Therefore, the probability that at least one of two randomly chosen women will be a Mary is $1-(1-P_{Mary})^2$. Likewise, define $P_{Brother}$ to be the probability of a randomly chosen man having a name that matches one of the brothers of Jesus of Nazareth. Again, we can estimate this probability by using either the Hachlili or the Ilan data. In either case, we likewise compute the probability that at least one of two randomly chosen men will have a name that matches one of the brothers of Jesus is $1-(1-P_{Brother})^2$.

Now we can put all this together to get what we are after:

$$P(T \mid \sim J) = P_{son-Judah}[1-(1-P_{Mary})^2][1-(1-P_{Brother})^2]$$

Computing P(T|J)

If we know for sure that the ossuary labeled "Jesus son of Joseph" *did* contain Jesus of Nazareth, what are the odds of observing the other five ossuaries in the tomb? This is again fairly easy to compute. As before, there are three factors:

1) The probability of the "Judah son of Jesus" ossuary, which is $F_2 P_{son-Judah}$

2) The probability of getting at least one "Mary" ossuary out of two ossuaries chosen randomly from women in the extended family of Jesus.
3) The probability of getting at least one "brother" ossuary out of two ossuaries chosen randomly from men in the extended family of Jesus.

A new wrinkle comes in here. Since this is definitely the family tomb of Jesus we are considering, we need to make sure that the family of Jesus is actually in it. This means that we should ensure from the beginning that the tomb contains:

1) Mary, the mother of Jesus, plus a number of other unknown women
2) James, Simon, Joseph, and Judah, the four brothers of Jesus, plus a number of other unknown men

This should be obvious. When we say "this is the family tomb of Jesus," what we mean is that his immediate family is in it, plus his (unknown) extended family. The intuition here is that all immediate family members, except the father Joseph, would be expected to be buried here. However, as is the case with all family tombs – some family members receive inscriptions while others do not. Thus, our interest here is in estimating the probability that the known family members of Jesus of Nazareth's family would receive inscriptions in a family of size 2*n*+2.[12] Assuming that the extended family members have names that are distributed according to Ilan or Hachili, let us work out the consequences of all this. Besides "Jesus son of Joseph" and "Judah son of Jesus," we will assume that the tomb contains *n* men and *n* women, but the distribution of names will be slightly distorted, because we have stipulated a few names. We can work out the new distribution of names quite easily.

The expected number of women named Mary is now:

$$E(Mary) = 1 + (n-1)P_{Mary} = nP_{Mary} + (1 - P_{Mary})$$

[12] Implicit in this is the assumption that a named member of Jesus of Nazareth's family is just as likely as a non-named member of the family to receive an inscription. This assumption may or may not correspond with reality. However, the extent to which it does not would only be insofar as we would expect the named family members to be more likely to receive an inscription. If that is the case – if, say, Simon is more likely than this "Matthew" to receive an inscription – the probability that this is Jesus of Nazareth's tomb will *drop* because it becomes more and more unlikely that *only 2 members of the known family would have an inscription*. Thus, this assumption – insofar as it fails to correspond to reality – *is favorable to Jacobovici's thesis*. This is important to note. We are offering a critique of the hypothesis, but the critique itself is *not* predicated on any assumption we have made. On the contrary, our assumptions, where and when we are forced to make them, favor Jacobovici's thesis and thus do not diminish the analytical power of our critique.

This implies that the new probability for finding a Mary within this family tomb of *n* women is:

$$P^*_{Mary}(n) = P_{Mary} + \frac{(1 - P_{Mary})}{n}$$

This confirms what we intuitively expect. Within the family tomb of Jesus, it is *more* likely to find a woman named Mary. But the "Mary-enrichment" effect decreases as the number of women in the tomb increases.

Likewise, the expected number of men having names of the brothers of Jesus is

$$E(Brothers'\,names) = 4 + (n - 4)P_{Brother} = nP_{Brother} + 4(1 - P_{Brother})$$

This implies that the new probability for finding a man with the name of a brother of Jesus within this family tomb of *n* men is:

$$P^*_{Brother}(n) = P_{Brother} + \frac{4(1 - P_{Brother})}{n}$$

Again, this is intuitively clear. Within the family tomb of Jesus, it is *more* likely to find a man with the name of one of his brothers, but this "brother-enrichment effect" decreases as the number of men in the tomb increases.

We can now put all this together to compute the term we wanted all along:

$$P(T \mid J) = F_2 P_{son-Judah}[1 - (1 - P^*_{Mary})^2][1 - (1 - P^*_{Brothers})^2]$$

At this point, it is natural to ask about the practice of naming sons after fathers. Isn't it *more likely* to have a son named Joseph in a family that *already has* a Joseph as the father?

The answer is yes, it does appear that families did quite often name one of their sons after the father. This is certainly true in the family of Jesus – he had a brother Joseph who was named after his father. The New Testament calls this brother both "Joseph" (Matthew 13) and "Joses" (Mark 6).

Will this effect change our calculation somehow? Will it enrich the number of expected Josephs in the family tomb of Jesus?

The answer is no, it will not. We already knew that Jesus had a brother named Joseph, so we have *already* enforced that fact above. So there is no "tendency" to account for in the family of Jesus. We enforced it already as a fact.

However, this issue does suggest that we should revisit our previous calculation for $P(T|\sim J)$ and account for the "Joseph enrichment factor" there. We will turn to that now.

Revised Computation of P(T|~J)

If we know that our tomb does not contain the family of Jesus of Nazareth, we need to account for the "Joseph enrichment factor" which will increase the probability of finding a son of Joseph named after him in this tomb. But there are actually two effects to account for.

In a family tomb with a "Jesus son of Joseph," there is a fairly high probability that the father Joseph of this Jesus will also be buried in the tomb. We need to account for that, too.

It may be, of course, that we are barking up a wrong tree and that neither of these really matter. In that case, there will be no increase in the expected number of Josephs in this family tomb. That is one extreme.

On the other hand, it may be that we should *always* expect to find *both* the father Joseph *and* a son named after him, in which case we would find two more Josephs in such a tomb than in an ordinary one.

Neither of these is a likely scenario. The answer is probably somewhere between these extremes.

Let us define a new "fuzzy factor" F_3 to account for our lack of knowledge. F_3 will be a number between 0 and 2 that represents the increase in the expectation value of the number of Josephs in a family tomb that contains the name "Jesus son of Joseph".

Since the expectation value in a tomb with *n* men was already nP_{Joseph}, it should be clear that the enhanced probability of finding a Joseph in such a tomb is exactly:

$$P^{+}_{Joseph} = P_{Joseph} + \frac{F_3}{n}$$

When F_3 is set to 0, there is no enhancement at all. That is the value we should choose in societies where families are neither more nor less likely to name one son after the father and where the father of a man named "Jesus son of Joseph" is never buried in the family tomb with him.

F_3 should be set to 2 in societies where the probability of naming a son after the father is 1 and where the probability of a father being buried with his son is also 1.

We expect that F_3 should be somewhere between 0 and 2, but we do not really know where it should be for the society of ancient Jerusalem. When we run calculations, we will be interested to know whether F_3 makes any difference or not, so we will run calculations over a range of values for F_3.

There is a corresponding enrichment in the probability that a randomly drawn man in the tomb will have one of the names of the brothers of Jesus of Nazareth. This probability is now:

$$P^{+}_{Brother}(n) = P_{Brother} + \frac{F_3}{n}$$

The net effect of all this is to change our previous estimate of $P(T|{\sim}J)$ slightly:

$$P(T \mid{\sim} J) = P_{son-Judah}[1-(1-P_{Mary})^2][1-(1-P^{+}_{Brother})^2]$$

Final Computation

Now we can put all our results together. Recall that we are trying to compute:

$$P(J \mid T) = \frac{P(T \mid J)P(J)}{P(T \mid J)P(J) + P(T \mid \sim J)P(\sim J)}$$

We have estimated the following:

$$P(J) = \frac{F_1}{N_J}$$

$$P(\sim J) = 1 - P(J)$$

$$P(T \mid J) = F_2 P_{son-Judah}[1-(1-P^*_{Mary})^2][1-(1-P^*_{Brother})^2]$$

$$P(T \mid \sim J) = P_{son-Judah}[1-(1-P_{Mary})^2][1-(1-P^+_{Brother})^2]$$

where:

$$N_J = \frac{1}{2} Ng P_{Jesus} P_{Joseph}$$

$$P^*_{Mary}(n) = P_{Mary} + \frac{(1-P_{Mary})}{n}$$

$$P^*_{Brother}(n) = P_{Brother} + \frac{4(1-P_{Brother})}{n}$$

$$P^+_{Brother}(n) = P_{Brother} + \frac{F_3}{n}$$

Note that the completely unknown probability $P_{son-Judah}$ factors out of the calculation, since it is a factor in both the numerator and denominator of the Bayes' Theorem equation.

The resulting equation is computable as a function of *n* and the various fuzzy factors F_1, F_2, and F_3. The first two of these fuzzy factors are required to be between 0 and 1, and the last is required to be between 0 and 2 so the fuzziness is nicely bounded.

Results

In this section, we will compute the results of $P(J|T)$ for a variety of choices of the input parameters. Again, the final results will vary depending upon the choices made with regard to the fuzzy factors we have delineated. Rather than provide our own estimate of the probability, which would require us to engage in a historical/archaeological discussion that is beyond our purview, we choose rather to offer five estimates that differ in the choices of the fuzzy factors and, accordingly, $P(J|T)$. We also choose the most and least optimistic values for each fuzzy factor, which as we have discussed will vary individually over a bounded range, so as to provide a bounded range of potential values that $P(J|T)$ might take.

Readers who would like to check our calculations (or run new ones with different assumptions) can download our spreadsheet from the following page:
http://www.ingermanson.com/jesus/art/stats2.php

The spreadsheet allows you to set six variables:

(a) The number of people in Jerusalem
(b) The number of complete generations during which ossuaries were in use
(c) Use Rachel Hachlili's population statistics or use Tal Ilan's
(d) *F1*: The relative probability that Jesus had a son
(e) *F2*: The relative probability that Jesus was interred in a tomb like the one at Talpiot
(f) *F3*: The number of "extra Josephs" one would expect in a family tomb containing a man named "Jesus son of Joseph"

Case 1: Advocate who wants the tomb to belong to Jesus of Nazareth

The numbers are chosen to be as favorable as possible to the "tomb hypothesis." This is the case no matter how absurd the assumptions might be from a historical perspective. The intention here is to make $P(T|J)$ as high as possible, regardless of rationality:

(a) $N = 30{,}000$ (Number of inhabitants of Jerusalem. Set as low as possible.)

(b) $g = 1$ (Number of generations in Jerusalem using ossuaries. Set as low as possible.)

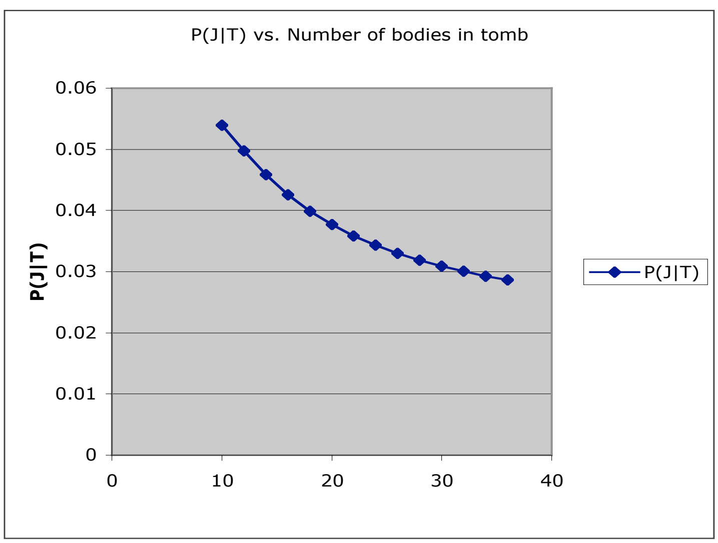
(c) Tal Ilan's probabilities for names

(d) $F1 = 1.0$ (Relative probability that Jesus had a son. Jesus was just as likely as any man to have a son.)

(e) $F2 = 1.0$ (Relative probability that Jesus could be buried in Talpiot. Jesus was just as likely as any man to be buried in Talpiot.)

(f) $F3 = 0.0$ (Expected number of extra Josephs in a tomb with a "Jesus son of Joseph" ossuary. No extra men named "Joseph" are to be expected.)

The results are plotted for a number of bodies in the tomb ranging from 10 up to 36:



Conclusion: The probability that the tomb belongs to Jesus of Nazareth could conceivably be as high as 1 in 18 if all factors are made as favorable as possible, irrespective of historical plausibility.

Case 2: "Indifferent" historian

The numbers here are chosen with the concept of indifference in mind. That is, the historian in this instance does not have a relatively strong opinion on any of the fuzzy factors. This is not to be taken as our estimation of the average scholarly response, which is probably better modeled as being somewhere between this and Case 4.

(a) $N = 50{,}000$ (Number of inhabitants of Jerusalem)

(b) $g = 2$ (Number of generations in Jerusalem using ossuaries)

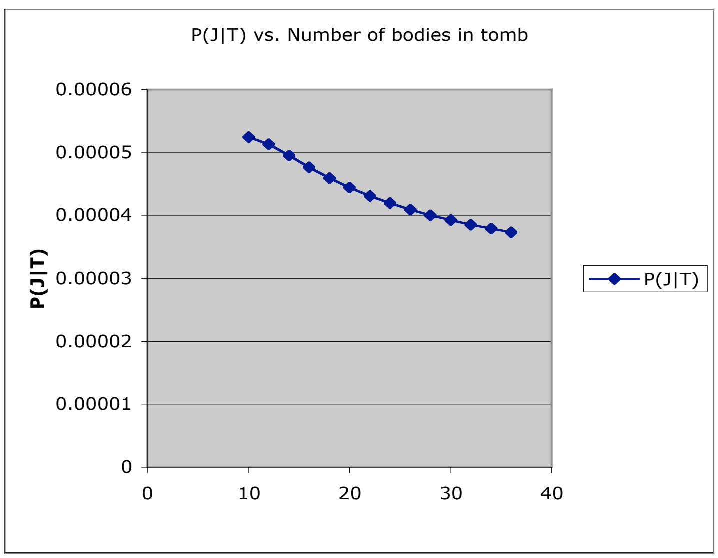
(c) Tal Ilan's probabilities for names

(d) $F1 = 0.01$ (Relative probability that Jesus had a son)

(e) $F2 = 0.5$ (Relative probability that Jesus could be buried in Talpiot)

(f) $F3 = 1.0$ (Expected number of extra Josephs in a tomb with a "Jesus son of Joseph" ossuary)

The results are plotted for a number of bodies in the tomb ranging from 10 up to 36:



Conclusion: The probability that the tomb belongs to Jesus of Nazareth is less than 1 in 19,000, with a choice of parameters likely to be made by a historian indifferent to the outcome.

Case 3: Historian inclined toward theory

The numbers are chosen to be quite favorable to the "tomb hypothesis," but staying within the bounds of historical reasonableness:

(a) $N = 50{,}000$ (Number of inhabitants of Jerusalem)

(b) $g = 2$ (Number of generations in Jerusalem using ossuaries)

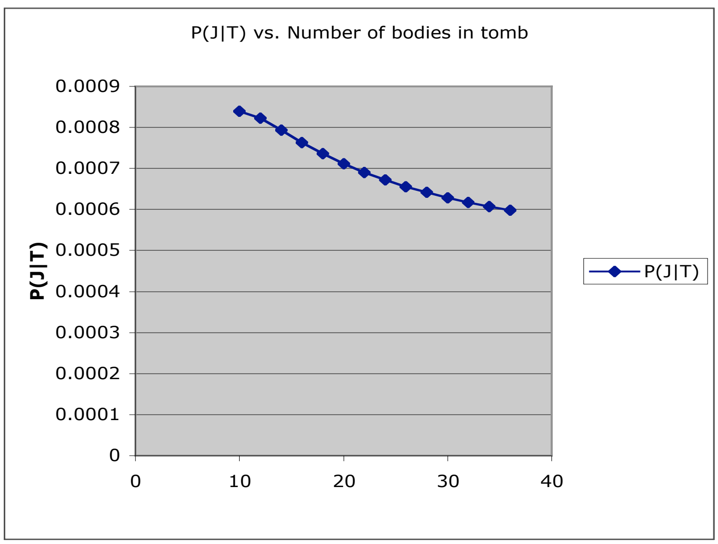
(c) Tal Ilan's probabilities for names

(d) $F1 = 0.1$ (Relative probability that Jesus had a son)

(e) $F2 = 0.8$ (Relative probability that Jesus could be buried in Talpiot)

(f) $F3 = 1.0$ (Expected number of extra Josephs in a tomb with a "Jesus son of Joseph" ossuary)

The results are plotted for a number of bodies in the tomb ranging from 10 up to 36:



Conclusion: The probability that the tomb belongs to Jesus of Nazareth is less than 1 in 1,100, even when choosing relatively liberal values of parameters so as to favor the tomb hypothesis.

Case 4: Historian disinclined toward theory

The numbers are chosen to be unfavorable to the "tomb hypothesis" while still being defensible from a historical perspective. Based upon an informal survey of most responses to the documentary's hypothesis – it seems that many scholars would place themselves here. That is, they are inclined to assign low values to the "fuzzy factors":

(a) $N = 80{,}000$ (Number of inhabitants of Jerusalem)

(b) $g = 2$ (Number of generations in Jerusalem using ossuaries)

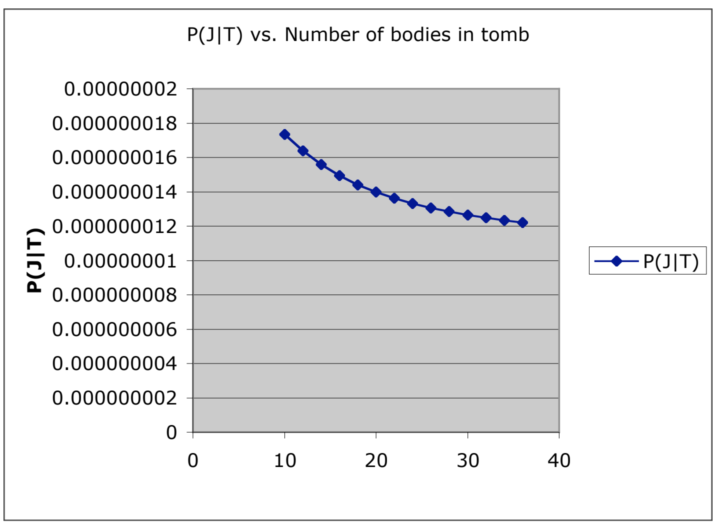
(c) Rachel Hachlili's probabilities for names

(d) $F1 = 0.001$ (Relative probability that Jesus had a son.)

(e) $F2 = 0.01$ (Relative probability that Jesus could be buried in Talpiot)

(f) $F3 = 1.5$ (Expected number of extra Josephs in a tomb with a "Jesus son of Joseph" ossuary)

The results are plotted for a number of bodies in the tomb ranging from 10 up to 36:



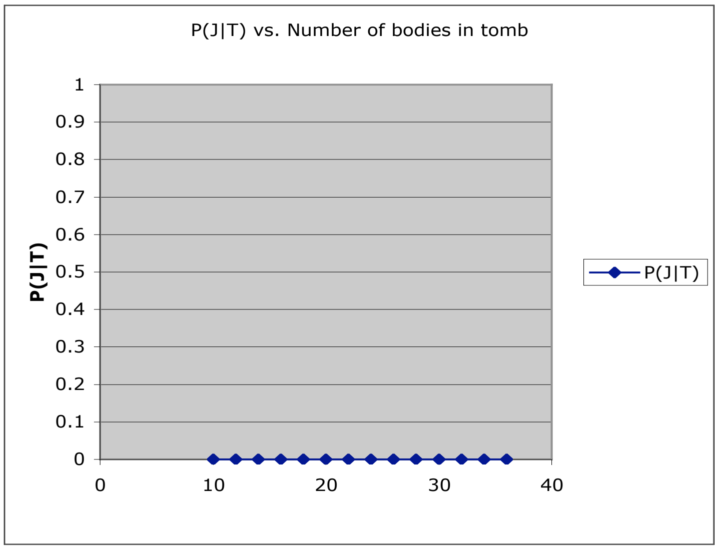
Conclusion: The probability that the tomb belongs to Jesus of Nazareth is less than 1 in 5 million if all factors are made unfavorable.

Case 5: Christian who insists that Jesus' body ascended to heaven

Only one number matters:

(e) *F2* = 0.0 (Relative probability that Jesus could be buried near Talpiot)

The results are plotted for a number of bodies in the tomb ranging from 10 up to 36:



Conclusion: If Jesus' body ascended to heaven, then the probability that this is his tomb is 0.

Assigning a Range to P(J|T)

Finally, it is worthwhile to assess the range of values that *P(J|T)* might take. Unfortunately, we have six factors that vary, which makes graphical representation impossible. Thus, let us vary two factors, *F1* and *F2*, simultaneously. Recall that *F1* is the relative probability that Jesus of Nazareth had a child and *F2* is the relative probability that Jesus of Nazareth could be buried at Talpiot.

The remaining factors will be held constant according to the assumptions in the "indifferent historian" case. Thus, *N* = 50,000, *g* = 2, *F3* = 1 and Tal Ilan's probabilities are used. With these conditions, we obtain the following results:

		F2			
		0.001	0.01	0.9	1.0
F1	0.001	0.0000000105	0.0000002092	0.0000094574	0.0000105138
	0.01	0.0000001046	0.0000010459	0.0000945656	0.0001051276
	0.9	0.0000094124	0.0000941210	0.0084398749	0.0093737827
	1.0	0.0000104583	0.0001045778	0.0093688530	0.0104044776

The rows represent the different values for *F1*, the columns for *F2* and the cells are the calculations of *P(J|T)* for every given *F1* and *F2*. Two observations stand out immediately. First, while it is the case that varying *F1* and *F2* have a large relative effect – that is varying from the lowest *F1*/*F2* to the highest amounts to a 1 million-fold increase – the absolute effect is minimal. That is, varying the factors from the least optimistic to the most optimistic only "purchases" a single percentage point. Second, the numbers are consistently low. Regardless of the value of either *F1* or *F2*, the likelihood that this tomb belongs to Jesus of Nazareth is consistently small. Even assuming that he is as likely as any man to have a son and to be buried at Talpiot – one still can find only a 1.04% probability that the Talpiot tomb belongs to him.

Discussion

Our analysis thus points in a very different direction than the conclusion of Jacobovici. Why is this the case? The answer to this question can best be seen by computing a simple estimate of *P(T|J)*. Let us, in this instance, remove *all* of the fuzzy factors. In other words, let us say that Jesus of Nazareth is just as likely as any man to have had a son (i.e. *F1* = 1) and just as likely as any man to have been interned at Talpiot (i.e. *F2* = 1). Let us also say that we expect no extra Josephs in the tomb (i.e. *F3* = 0). Additionally, let us take the rest of the assumptions made by our "indifferent historian" in Case 2 above. Thus, we assume a population of Jerusalem of 50,000 people and the total number of generations interned in ossuaries is two. We also use Tal Ilan's demographic data. Finally, we assume only 10 people were interned in the tomb.[13]

[13] All of these have the effect of maximizing the value of *P(J|T)* while retaining reasonable assumptions about demography.

We still use our basic Bayes' Theorem formulation. That is:

$$P(J \mid T) = \frac{P(T \mid J)P(J)}{P(T \mid J)P(J) + P(T \mid \sim J)P(\sim J)}$$

With the stated assumptions, we obtain:

P(T|J) = 0.687

P(T|~J) = 0.216

P(J) = 0.005

P(~J) = .995

Returning to our equation, we obtain:

$$P(J \mid T) = \frac{0.687 \times 0.005}{0.687 \times 0.006 + 0.216 \times .995}$$

$$P(J \mid T) = \frac{.003}{.218}$$

$$P(J \mid T) = .014 = 1.4\%$$

This is far from the 600 to 1 chance hypothesized by Jacobovici. The reason should be clear when we recall the fundamental intuition of Bayes' Theorem. We are interested in defining *P(J|T)* in terms of *P(T|J)*. This requires us to consider two factors, neither of which Jacobovici considered.

The first is the unlikelihood of ever finding Jesus of Nazareth in the first place. This value – even under these very optimistic assumptions – is quite low, just 0.5%. Relatedly, the likelihood that we have not found Jesus of Nazareth is a very sizeable 99.5%. This must be considered in any evaluation of the tomb. To fail to do so is, again, to commit what is known as the prosecutor's fallacy. One cannot focus solely upon the uniqueness of the evidence gathered. Its uniqueness must be weighed against the uniqueness of the claim. While Talpiot might have some unique evidence that points to Jesus of Nazareth, its descriptive power is necessarily diminished when we consider just how unlikely it is that we would ever find his tomb in the first place.

The second is the extent to which the names in the tomb provide a clue to which Jesus was interned there. The good news for Jacobovici's hypothesis: we can expect with 68.7% likelihood that Jesus of Nazareth would be buried with at least one Mary and at least one brother. The bad news: *we can also expect 21.6% of all people named "Jesus son of Joseph" who are not Jesus of Nazareth to be buried similarly*. In other words, Talpiot does *not* provide all that unique a clue at all. Why is this the case? It is for the reason that historians, archaeologists and New Testament scholars have been stating since the day the film was announced: *these names are common*. Thus, while it is true that finding four particular common names in a cluster is uncommon, as Jacobovici and others have responded, this is beside the point. The point is that the names in Jesus of Nazareth's family were not sufficiently unique such that a tomb that matches two of them decisively points toward Jesus of Nazareth. Indeed, the difference between $P(J|T)$ and $P(T|{\sim}J)$ is far from decisive. *Many* men named "Jesus son of Joseph" can be expected to have been buried with at least one woman named Mary and at least one man with a name that follows the names of Jesus of Nazareth's brothers. *Common names mean that the names themselves do not take us very far in terms of identifying the owner of the tomb.*

Thus, it should be clear that Jacobovici's inferential errors had a sizeable and beneficial effect on his hypothesis. The failure to consider $P(J)$ and $P(T|J)$ dramatically inflated the estimate of $P(J|T)$, biasing it (in the statistical sense of the term) from its expected value and toward the conclusion of the documentary. Factoring in the miscellaneous computational errors we also reviewed, it should be clear why our figure is dramatically lower.

When we begin to consider the fuzzy factors, the value of $P(J|T)$ begins to drop even further. It is important to note that it can *only* fall from this value of 1.4%. Jacobovici implicitly assumed $F1 = 1$, $F2 = 1$, and $F3 = 0$. All are unrealistic assumptions. If we adjust them to be more realistic, $P(J|T)$ will fall below 1.4%. Much of the "damage" will be done by $F1$, the fuzzy factor that assigns a relative probability to Jesus of Nazareth having a child. Given the unanimous and deafening silence of the historical record, it seems to us unlikely that this value could be taken above 0.05 without resort to a tendentious and error-filled argument. With $F1 = .05$, $F2 = 1$ and $F3 = 0$, the value of $P(J|T)$ drops to 0.08%. When $F2$ is lowered and $F3$ is raised to correspond better with our expectation of reality, $P(J|T)$ will drop even further.

Conclusion: Statistics above All?

Rather than conclude by recapitulating our hypothesis, we feel we should take the opportunity to respond to an insightful argument offered by Professor James Tabor, who has been a thoughtful supporter of the theory of Jacobovici. On his *Jesus Dynasty Blog*, Tabor writes:

> A statistician, as statistician, is not primarily focusing on prosopography, that is, matching ancient names to known historical characters. That is the task of the historian who then seeks to determine if there is any potential "fit" between this cluster of names, with its configurations, and that of any identifiable persons/family in our records…
>
> I am not optimistic that more advanced statistical models can be effectively applied to questions of historical prosopography since the kinds of identifications and subtle correspondences used are not easily quantified. Is Mariamene an appropriate name for [Mary Magdalene]? How could you put a number on it? Is it significant that her ossuary is decorated and her inscription is in informal Greek? How is that quantified? Does it matter that the name Yeshua bar Yehosef is written in a very messy graffiti style while the others are elegant and block? How do you put a number on that? What of how the ossuaries were placed in the various kokim, and with names grouped in twos and threes? Are there hints of potential relationships implied? I have about 25 other factors of this sort that I am considering in formulating my own prosopographic proposal, including the symbol on the tomb that comes from contemporary temple gate imagery. As far as I can tell many of these factors can not be quantified.[14]

This raises an interesting question: does statistical analysis such as the kind that we have outlined here preclude historical and archaeological analysis?

While we find ourselves agreeing with Dr. Tabor on several important points, we believe that the answer is no. To clarify our position, it is valuable to outline what we believe we have and have not delineated in this article.

At a fundamental level, statistical analysis is a formalization of the proper manner of descriptive inference. Thus, we would argue that the first accomplishment we have made in this essay is formally to outline how analysis of the Talpiot tomb should proceed. This is the case even if one

[14] James Tabor. "Probabilities, Statistical Theory, and the Talpiot Tomb." March 19, 2007. http://jesusdynasty.com/blog/2007/03/19/probabilities-statistical-theory-and-the-talpiot-tomb/. Accessed March 26, 2007.

ultimately decides that a formal probability is incalculable. Even if it is impossible to assign actual values to the sundry variables that we have delineated – *one nevertheless must take these variables into account*. This is, as we indicated above, the fundamental methodological mistake of Jacobovici. He failed to consider *P(J)* and *P(T|J)*. Even if he had chosen a non-quantitative route for his argument, the failure to consider these factors would still invalidate his conclusions. The reason is that, even if one chooses to avoid the mathematics behind statistical analysis, one must still obey the rules of descriptive inference it delineates. When one fails to do this, one runs the risk of committing an inferential fallacy of some sort – just as Jacobovici has committed the prosecutor's fallacy.[15]

In addition to outlining the proper manner in which an argument about Talpiot should proceed, we also would argue that we have here delineated a *range* of values that the final *P(J|T)* can take. In other words, we are in full agreement with Dr. Tabor that the job of the "statistician" does not preclude the job of the historian or the archaeologist. This is why we have delineated a series of "fuzzy factors" and have demurred from assigning final values to them. We are not formally trained in either history or archaeology. It is not our business to assign values to these numbers. What we have done, however, is identify where the historical and archaeological debates can influence the final outcome. While we might lack the scholarly background in history to predict the results of the sundry debates that are ongoing, we nevertheless have the capacity to identify where, how and why those results will affect the final estimate of *P(J|T)*. For instance, a prosopographical discussion of the family of Jesus of Nazareth, above all a serious investigation of the likelihood that he had a son named "Judah," will influence *P(T|J)*. An archaeological/historical discussion about whether one might expect Jesus of Nazareth to be interned in a

[15] Dr. Tabor, in arguing for the more simple method advanced by Dr. Feuerverger and explicitly against our method (which he calls "a more Bayesian model"), asserts that the measure of Feuerverger embodies what he calls "the Ockham's razor of probability theory." As it is, however, any argument about the ownership of this tomb that relies upon Feuerverger's figure without reference to the other factors we have delineated will be guilty of the inferential errors we have also delineated. And while, following Ockham, simplicity is a virtue in any argument, it is *not* the highest virtue: simple arguments with inferential errors are not to be preferred to (slightly) more complicated arguments that lack such errors. We would also note that while we discussed our basic hypothesis with Dr. Tabor, we did not give him an advance copy of this essay. Accordingly, we are not sure that his knowledge of our methodology was sufficient for this critique, which predates the public release of this essay. See James Tabor, "Statistical Clouds, Fuzziness, and Ockham's Razor." March 25, 2007. http://jesusdynasty.com/blog/2007/03/25/statistical-clouds-and-fuzziness. Accessed March 26, 2007.

tomb like the Talpiot tomb, placed in the particular ossuary in question, and so on, will influence *P(J)*.

These debates are therefore embodied in our "fuzzy factors," which each vary over a small range. While we cannot predict what their particular values will be, and while we recognize (following Dr. Tabor) that it is possibly the case that their expected values cannot be quantified because it would require placing numbers on what are essentially non-numerical concepts, we can nevertheless vary these factors between 0 and 1 to see how this variation affects $P(J|T)$. It is in this manner that we can offer a range of values for $P(J|T)$. This is what we have done.

What we have *not* done is delineate an *expected value* for $P(T|J)$, which we would agree with Dr. Tabor might in fact be incalculable. This would require us to take positions on matters which are beyond our purview, namely the historical/archaeological debate that is now ongoing, and to quantify what is possibly not quantifiable.

Thus, we find ourselves in both agreement and disagreement with Dr. Tabor. On the one hand, we think that statistical analysis *cannot* stand as a substitute for the historical/archaeological debate – and that, at some point, certain unquantifiable elements might preclude the assignment of an expected value. On the other hand, we think that statistical analysis *can* be taken further than Dr. Feuerverger has taken it, and further than Dr. Tabor believes it can be taken.

Specifically, we think that our model possesses the right combination of flexibility and clarity not only to allow for the prosopographical debate Dr. Tabor rightly wishes to see commence, but also to indicate where the results of that debate will have an effect and what kind of effect that might be. Generally, we believe that it can offer two valuable services: (a) the methodological outline of how any argument – quantitative or non-quantitative – should proceed; (b) a range of values for $P(T|J)$.

About the Authors

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