Probability, Statistics, and the Talpiot Tomb

Kevin T. Kilty, Ph.D., P.E.,
Mark Elliott, Ph.D.,
LCCC, Cheyenne, Wyoming
June 10, 2007

Simcha Jacobovici, producer of a popular documentary on the Jesus Family Tomb, hired a statistician, Andrey Feuerverger of the University of Toronto, to determine what probability and statistics might have to say about the issue. Critics have mainly garbled what Feuerverger said, or have misunderstood and misrepresented this work. For example *The Jerusalem Post*, on February 27, 2007, characterized the results in the following way.

> The filmmakers asked Andrey Feuerverger ... to study the likelihood of the cluster of resonant names found in the Talpiot tomb being merely coincidental. He concluded, according to the Discovery Channel, that the odds are at least 600 to 1 in favor of the Talpiot Tomb being the Jesus Family Tomb. In other words, the conclusion works 599 times out of 600.

This is badly worded. Lay people would read this and conclude that the Jesus Family Tomb is a sure thing; while most statisticians would say that no calculation for such a specific claim is possible. Other scholars connected with the controversy claim that this result is entirely expected and means very little if anything. In fact these critics, without any calculations to back up their assertions, claim that such a collection of names in one tomb is hardly surprising because the names involved are very common.

Stephen Pfann, a scholar at the University of the Holy Land, claims on a web document [1], for example, that

> The names Mary (2x), Joseph/Joseh (2x), Judas and even Jesus, found in the Talpiot tomb should well be expected there (or in almost any other tomb in the area, for that matter). *These are simply the most common names of the day*... If other tombs contained so many inscribed ossuaries, the name census in most other tombs would be very much the same.

We intend to show is that this is not, in fact, the case. While Feuerverger's specific approach may be off-target, we feel he is essentially correct in con-

cluding that the group of names associated with this tomb are hardly something a person should have expected to find.

In what ranks among the more fantastic statements regarding the controversy Amos Kloner, the Bar Ilan University Professor who engaged in the original excavation of this tomb, says in a National Geographic News story [12] that archaeological and historical evidence trumps the Discovery Channel Documentary claim

> Joseph, Mary, and their son Jesus were a poor family from Nazareth. There is no proof they even lived in Jerusalem.

If Kloner intends to mean by this that no portion of Jesus' family ever lived in the Jerusalem area, then this is so demonstrably untrue[1] that we tend to think instead that this is a misquotation. Nevertheless issues raised by the Talpiot Tomb have stirred emotions and have every chance of becoming esoteric and interminable disagreements among experts without settlement. Before this happens we wish to do the following.

1. Since Feuerverger's work is so widely misquoted and misunderstood we would like to explain its essense, as we understand it, to non-statisticians. We also want to present an argument about why it seems off-target in this instance.

2. Another concern of ours is whether other selected statistics bearing on this topic are accurate and on target. In particular we would like to respond to recent discussion about the necropolis known as *Dominus Flevit* utilized as a comparison to the Talpiot Tomb.

3. More broadly we would like to determine whether or not probablility and/or statistics apply in any pertinent way to the analysis of a Jesus Family Tomb. If they do, then what do they indicate?

How statisticians work

Feuerverger's calculations probably make no sense at all to a person not familiar with how statisticians go about making inferences. Therefore let us

[1] On Mary living in Jerusalem see Acts 1:14. Note "as well as his brothers." On James in Jerusalem see Acts 15:13; 21:17-18; Gal 1:19; 2:1-10. Also in Josephus. Ant. 20:9:1.

discuss statistical inference for a moment. Statisticians make inferences using the numerical value of a *statistic*.[2] Making inferences involves a sequence of steps as follows:

First, the statistician will decide on a question to examine and form a null hypothesis and an alternative with regard to this question. The alternative hypothesis is the focus of interest. It implies that something anomalous has occurred, for example that a population characteristic exceeds some particular value. The null hypothesis is the logical complement to the alternative. In effect it expresses that the observed data present no evidence of anything anomalous. The null hypothesis is also known as the nominal hypothesis as a result.

Second, the statistician will formulate a particular sample statistic with which to test the hypothesis. The nature of this statistic will suggest to the statistician a particular sampling distribution to use for calculations. For instance, using the sample mean value leads to either the normal distribution (bell-curve) or Student's t, while using the sample standard deviation leads to the Chi Squared (χ^2) or the F ratio distributions. The sampling distribution has a mathematical form or tabulation that allows the statistician to make calculations and comparisons regarding the actual population it represents; whereas the actual population may not support calculations.

Third, the statistician divides the sampling distribution into two regions: the acceptance region (generally large, typically something like 95% of the sampling distribution or more) and the rejection region. If the observed statistic achieves a value that lands it in the rejection region, the statistician will, in effect reject the null hypothesis, or accept the alternative to the null (nominal) hypothesis. In effect this implies that there is evidence to suppose that something anomalous has occured. On the other hand, if the value of the observed statistic places it in the acceptance region, the statistician will *provisionally* accept the null hypothesis. In effect acceptance means only that there is insufficient evidence to reject the null hypothesis. The exact value pertaining to this division of regions is somehat arbitrary and the statistician will make a judgement of the best possible dividing point based on everything the statistician knows about the topic.

[2] A sample statistic is a numerical value that results from calculations involving observed data; whereas, without the "sample" qualifier the statistic usually refers to a characteristic describing a population. The most common such statistic is a mean value or sample mean. There are also statistics such as rank-order, which appear less numerical than does a mean value.

Through this procedure the statistician comes to one of two conclusions. Either the sample value could easily arise from chance leaving insufficient evidence to decide against nominal circumstances; or, the sample value is so different and so unlikely to occur in nominal circumstances, that the statistician decides instead against nominal circumstances.[3] What is significant about such a procedure is that it is not suited to answering highly specific questions, and this seems to be the origin of its results being misunderstood so easily.

Not all statisticians will use the acceptance/rejection form of inference. An alternative way to report the results is for the statistician to report the percentage level of the distribution remaining at the value of the statistic or above this value. So, to report that the statistic value leaves less than 1% of the sampling distribution above is reported as $p < 0.01$ for instance. However, in either formulation what the statistician is seeking is evidence from the statistic value that some unusual event has or has not occurred under the presumption of nominal circumstances.

Finally, not all statisticians work along these four or five steps outlined above. Another school of statistics makes use of *Bayes Theorem* to modify prior beliefs and maintain consistency with accumulating evidence. We will have more to say about this approach in a later section.

Feuerverger's approach

Let us now examine Feuerverger's analysis to see how it compares to typical statistical inference.

First, the hypothesis in question is that of whether the assemblage of names in the Talpiot Tomb is unusual (an unexpected sequence of names) or utterly expected. If it is unusual then one might plausibly say that the names point to a unique family–the Jesus Family. Let us re-iterate something we said earlier. The typical statistical analysis can only establish that the assemblage of names under the assumptions made is or is not unusual. The further step of identifying a particular family belongs elsewhere probably.[4] Therefore the application of statistics at the very first step is going to

[3]It is possible, of course, that an improbable value of observed statistic could cause the statistician to reject a null hypothesis that is true or accept a null hypothesis that is false. These are two of the possible errors committed in statistical inference.

[4]Although a Bayesian approach might do a better job than the classical approach in

disappoint almost everyone. Moreover, as Feuerverger himself says in a web page [3] devoted to explaining his procedure, this is not a problem typical of classical statistics, but that an analogous formulation is possible. The nominal hypothesis in this formulation is that the group of names in the Talpiot Tomb arose purely by chance; and an alternative is that the group of names is not simply coincidental. The alternative here is not altogether clear. We gather that what Feuerverger means is that the alternative consists of name groups that are not only improbably the result of chance, but also contain names that could plausibly come from Jesus' family.[5]

Feuerverger's second and third steps, to decide on a statistic and a value that separates the nominal and alternative hypotheses, is complicated by there being no accepted statistic, and therefore no accepted sampling distribution, for such a problem. Feuerverger settles on a measure of "surprisingness." This is essentially just the probability of obtaining the cluster of names in the Talpiot Tomb by random draws from Rahmani's 1994 list of ossuaries [6] and Tal Ilan's 2002 compilations of names from many sources [5]. Therefore the sampling distribution resembles a sort of multinomial distribution, with the additional stipulation that combinations within the alternative contain no names that could not have come from the Jesus Family.

Finally, Feuerverger uses the alternative method of reporting results that we alluded to in the previous section. Rather than dividing the sampling distribution into acceptance and rejection regions of fixed percentage, he simply reports the total percentage probability of the collection of names in the Talpiot Tomb plus other compatible groups that have equal or lesser probability. From an estimate that some 6600 ossuaries exist in total, Feuerverger further estimates something like 1100 "trials" of six ossuaries each. In this case Feuerverger is using the total number of ossuaries estimated to exist and dividing by the number of ossuaries in the Talpiot Tomb to arrive at a number of *trial Talpiot tombs*. In fact, from Table 2 in Rahmani's catalog we find a mean value of seven to eight ossuaries, and a median value of five ossuaries per cataloged tomb, but only a median or mean value of three are inscribed. Multiplying the probability obtained from this distribution by this figure of 1100 trials, Feuerverger finds that a similar tomb with Jesus Family names might occur in 1 of 600 cases. As a statement of where the current assembly

this instance as we will demonstrate in a later section.

[5]Feuerverger says by way of example is that having the name Feuerverger inscribed on one ossuary would be rare but would invalidate the tomb as belonging potentially to the Jesus Family, and would not then be included in the alternative.

of names or even more unusual groupings fits in the sampling distribution one may see it equivalent to a p value between 0.01 and 0.001 in the more typical sort of statistical reporting.

Objections to Feuerverger's approach

Let us deal with several objections immediately. First, the multiplier of 1100 used to estimate the number of tomb "trials" involved is simply a number obtained from a very simple calculation and appears *ad hoc*. A more rigorous value would involve complex analysis about the actual contents of all tombs–something we do not even know at present because all tombs haven't been discovered and cataloged. In the absense of such a complete catalog, we would use the existing catalogs of tombs and ossuaries as a guide to those not yet discovered–a random sample of the universe of tombs in other words. Certainly Feuerverger's value of 1100 isn't an unreasonable estimate, though – it can't be wrong by a factor of ten.

Second, real families do not draw names for their children randomly. If they were to do so, then there possibility would be some family having three sons named identically. As Tal Ilan says, despite a limited pool of names, Jews in Palestine do not appear to ever use identical names for siblings.[6] Obviously, then, such cases which occur through random draws have to be excluded from the sampling distribution.

Another obvious problem with a sampling distribution built from random name assignment is that it does not account for naming tradition. Families make conscious decisions to name their children after honored relatives and dear friends.[7] Also, Jews in first century Palestine tended to use names from the family of Macabees–a predominate factor in explaining the frequency of individual names.[8] Therefore because of these factors, particular groups of names within specific families occur more frequently than raw frequencies of individual names would suggest. In fact, they may be many times more common. We do not see how to analyze this influence except through the analysis of actual family names. This would be a large effort.

[6] See Tal Ilan [5] section 3.1.4, siblings on page 33.

[7] See Tal Ilan [5] section 3.1 on page 32 for example.

[8] See both Bauckham [4] on page 74 and Tal Ilan [5] section 1.1.1.2 on page 6.

Is Feuerverger's calculation off-target?

The real question people wish to know the answer to is "Does the Talpiot Tomb contain the remains of Jesus and some of his family members?"[9] Feuerverger's calculation doesn't directly answer this question. Instead, his approach can tell us only that the combination of names is unexpected and possibly came from Jesus' family–a far more modest target. Let's undertake example calculations to show why Feuerverger's approach is possibly off-target. Assume a tomb with six ossuaries with names inscribed. What is the most common group of names and what is its probability of occurence? The name frequencies needed for the calculation we can take from Bauckham's listing[4]. Nearby Table 1 shows the name frequencies we employ for all calculations.

Name	Number of Instances/Total	Frequency (f)
Simon	243/2625	0.093
Joseph	218/2625	0.087
Lazarus	166/2625	0.063
Judas	164/2625	0.062
Jesus	99/2625	0.038
Matthew	62/2625	0.024
Yoseh	9/2625	0.003
Mary	70/328	0.213

Table 1: Jewish names in first century Palestine. The data are largely from the total of all sources in Bauckham's [4] Table 6, page 85, except that we have separated Yoseh as a separate entry. We have used Feuerverger's number for the occurrences of Yoseh, but this agrees also with Ilan's compilation.

However in order to answer the question we just posed, and neglecting all of the issues with real family names not being randomly acquired, we must look not only at name frequencies, but also at the relationship among the persons in the Talpiot Tomb. There are many possible consistent relationships. Taking the males names for example, one could be looking at two brothers each with a son; or, one could be looking at a father, two brothers

[9]The inscriptions in this tomb include *Jesus son of Joseph, Mariam, Mariamnou, Yoseh, Matthew, and Judah son of Jesus.*

and one son of one of the brothers; or one could be looking at a father and three sons. The graphics nearby show this. This example alone demonstrates some of the difficulty in separating names groups that belong to Feuerverger's nominal and alternative categories, because the left side structure does *not* represent a possible Jesus Family; while the right side structure does.

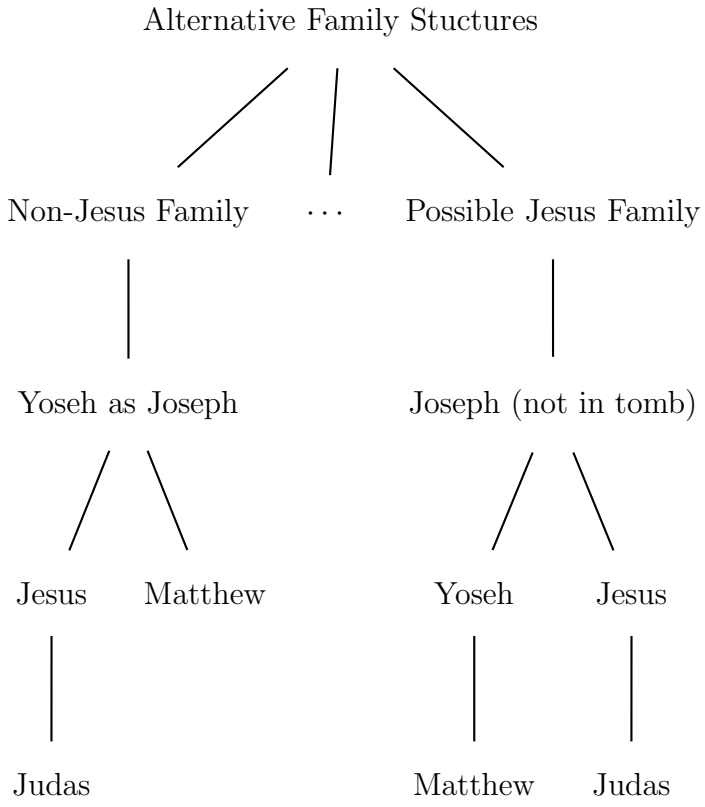

Figure 1: Two among many alternative relationships of males persons to one another in the Talpiot Tomb. In one the person named Yoseh is the father mentioned on the "Jesus son of Joseph" ossuary. In the other alternative the father Joseph is not present in the tomb, and two of the ossuaries are those of brothers; while the remaining two are those of cousins. There are other consistent possibilities, indicated here by the ellipsis.

Two of the names in this hypothetical tomb are of unrelated women, who may have the same name–Mary ($f = 21.3\%$) is most common.[10] Assume

[10]The symbol f refers to name frequency in these instances.

among the four males a family structure of three brothers and the son of one of the brothers. The father is not also in the tomb, but known through inscription. The three brothers would each have a different name, but there are six different ways to distribute names among the three sons. The names would be a Simon ($f = 9.3\%$), a son Simon, a Joseph ($f = 8.7\%$), and either a Lazarus or a Judas, these last two names being just about equally frequent ($f = 6.3\%$). Multiplying the frequencies together under the assumption of independence, and adjusting for the combinations, we arrive at about 2.8×10^{-6} for the probability. That is, about 3 out of one million equivalently random tombs of six ossuaries would contain this set of names. Now let us calculate similarly for the Talpiot Tomb. Here we have two Mary's again, Joseph[11], Jesus ($f = 3.8\%$), Matthew ($f = 2.4\%$), and Judas. The probability calculated similarly in this case is 2.6×10^{-7}. Figure 2 shows the alternative computational structures.

[11]The actual inscription for this name is Yoseh, but we have equated it to Joseph momentarily to produce a conservative probability.

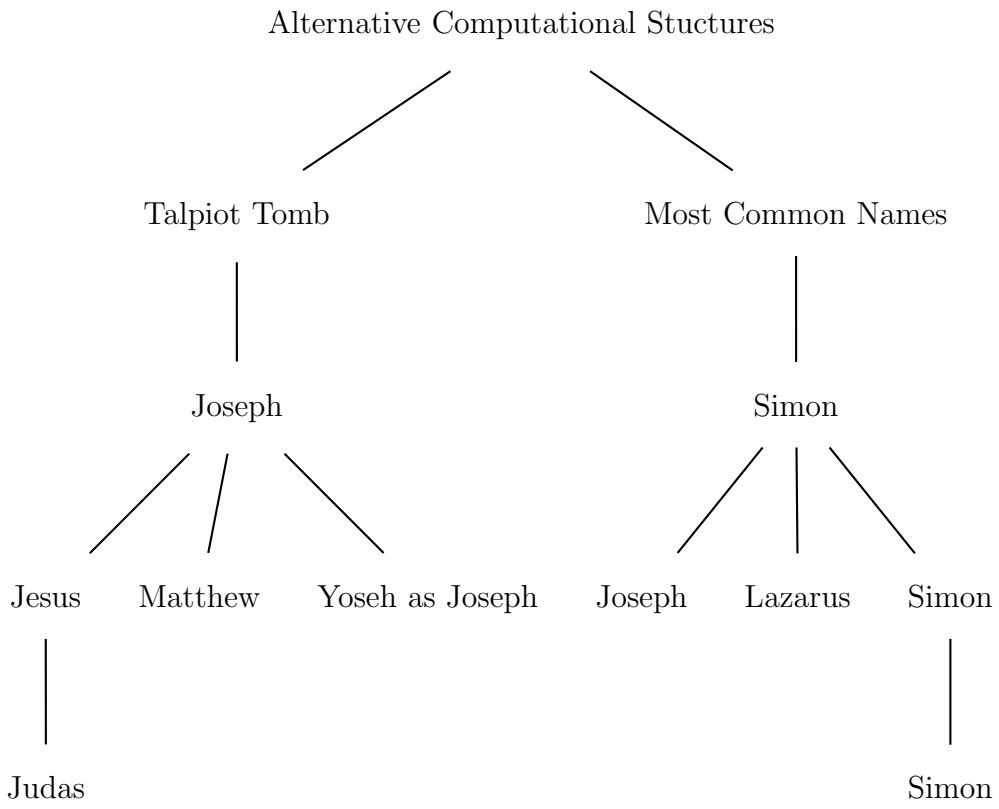

Figure 2: Two hypothetical relationships among male persons for purposes of calculating probabilities. In each case the two female persons are both named Mary.

The Talpiot Tomb names are quite a bit less likely to find as a combination compared to the most likely names–as a likelihood ratio it is about 11:1. There are many, many ways to distribute names among groups of size six in which one or more of the names occurs more frequently in Bauckham's list than the six names in the Talpiot Tomb; and each of these is anywhere from 11 to perhaps only 1.1 times more likely than names of the Talpiot Tomb, but they accumulate a huge proportion of the sampling distribution. This partially explains how the Talpiot Tomb can contain six names that occur relatively frequently in the general population, yet it also be true that the combination of these six names is quite "surprising" in Feuerverger's estimation.

Let us analyze this sampling distribution further. In typical statistical

problems the number of individuals involved in the actual population is very large, and if we look at not-too-fine a scale of detail, we can rest assured that the actual population fills its distribution of possible combinations fully making it resemble the sampling distribution, which is what we use for calculations, closely. However, the situation involving names in tombs in the Jerusalem area is new territory for statistical analysis, and we owe everyone a thorough analysis of this "multinomial" sampling distribution and its resemblence to the actual collection of names in tombs. Let's look at frequencies of names in various first century sources and try to determine first if they are consistent with one another, and second, what this may have to say about the issue of the sampling distribution for groups of names occuring on ossuaries in a tomb.

Male Names Rank		Female Names Rank	
Total	On ossuaries	Total	On ossuaries
Simon	Simon	Mariam	Mariam
Joseph	Joseph	Salome	Salome
Lazarus	Judas	Shelamzion	Shelamzion
Judas	Lazarus	Martha	Martha
John	John	Joanna	Shiphra
Jesus	Jesus	Shiphra	Joanna
Ananias	Ananias	Berenice	Imma
Johnathan	Matthew	Imma	Mara
Matthew	Johnathan		
Manaen	Yeozer		

Table 2: Table comparing the ten most common male and eight most common female names on ossuaries against those derived from major literary sources plus inscriptions from tomb and ossuaries. Data from Bauckham [4].

Table 2 compares common names over-all to those from ossuaries. Looking at males names first, the totality of names from all sources in Bauckham [4] shows that rank in the top ten are Simon, Joseph, Lazarus, Judas, John, Jesus, Ananias, Johnathan, Matthew, and Manaen. Looking at the top ten from ossuaries only we find, Simon, Joseph, Judas, Lazarus, John, Jesus, Ananias, Matthew, Johnathan, and Yeozer. The rankings are extremely similar even though there are differences in frequencies–Simon, for instance,

makes up 9.3% of names overall while making up 13% of names on ossuaries.[12] Rankings being almost identical suggests that names inscribed on ossuaries follows the same sorts of conventions as naming in society at large. In fact, to say that the rankings are almost identical understates how similar they are. If it weren't for the names of around two dozen inscriptions the rankings would be identical. The same is true also of women's names. In other words, the distribution of name frequencies found through the totality of sources[13] works well to produce the distribution of names observed on ossuaries. The converse is also true, that inscriptions on ossuaries represent a sample of naming broadly through society, despite Pfann's claims to the contrary.

However, we are not in business here to analyze just names, but rather groups of names of related persons from tombs. This takes us into a far more complex sort of sampling problem. The simplest possible group is the association of one name with one other. How well, for example, do pairs of names drawn randomly from the general frequency distribution of names mimic names inscribed on pairs of ossuaries in real tombs? From Rahmani's catalog [6] (Table 2) we find that the median number of ossuaries in tombs is five. Not all of these would be inscribed. The mean and median number of inscribed ossuaries per tomb is three. Therefore let us look at the expected number of tombs containing a two-name association among three inscribed ossuaries–a Mary and a Jesus, for instance–and compare this to what is actually cataloged.

Even this simple example takes us into a very complex problem because we have to make additional assumptions about typical tombs. For instance, one might think that the number of ossuaries bearing male names should just about equal those with female name inscriptions. However, Bauckham's listing indicates that males name inscriptions on ossuaries occur with about three times the frequency of female names; and we will employ this fact when dealing with calculations of probabilities of name inscriptions of mixed sexes. For example, the name Mary occurs with about 21.3% frequency among

[12]If one takes the point of view that being named Simon or not is a binomial process, then one can calculate that the 95% confidence bounds on the frequency of men named Simon is between 7.5% and 11% in Bauckman's [4] total listing and between 8.6% and 18% in the listing of ossuaries alone. The two confidence intervals overlap enough to suggest no significant difference in frequencies computed from either.

[13]Bauckham's [4] lists on page 85 included the Catalogs of Tal Ilan [5] and Rahmani [6] which considered ossuaries, New Testament sources, texts from the Judean Desert, and names taken from Josephus.

women, or about 5.3% in a full population of ossuaries; Jesus with about 3.8% frequency among men, so about 2.9% in full. Using a multinomial distribution a three-ossuary tomb has a probability of $3!(0.053)(0.029)(0.918) = 0.008$ of containing one Mary and one Jesus. Therefore, considering that there may be in the neighborhood of 150 tombs with inscribed ossuaries known[14], one would expect $0.008(150) = 1.2$–one or two tombs among those known already that contain both a Jesus and Mary. The actual list includes three: Talpiot, *Dominus Flevit*, and a tomb from the Mt. of Offense.[15]

At first blush this calculation suggests that one ought to be able to calculate probabilities of groups of names in tombs using name frequencies and be within one or two of the observed number. However, this is true only in a limited sense. It is true that the inscriptions on ossuaries in a tomb do follow name frequencies for the more common names. For example, consider a hypothetical tomb the size of the necropolis *Dominus Flevit* [11], which contains 43 inscribed ossuaries. Just knowing the number of inscribed ossuaries and name frequencies, and assuming that three-quarters, or 32, of the ossuaries contain a male name inscription, we can calculate that *Dominus Flevit* ought to contain $(32\frac{218}{2625})$ = two or three Josephs, $(32\frac{164}{2625})$ = two Judahs, $(32\frac{99}{2625})$ = one Jesus, and $(11\frac{70}{328})$ = two Marys. This is quite close to what the tomb complex at *Dominus Flevit* actually contains.

Yet, it should stand without saying that names so rare that they are found only once or twice in the over-all compilation might be greatly over or underrespresented as inscriptions on ossuaries. Moreover, when one engages in the more complex analysis of larger (> 3) collections of names in tombs, then one cannot use name frequencies to calculate accurately how many tombs contain a particular combination of names. An example ought to illustrate the problem; so, let's take the four most significant names in the Talpiot Tomb. There are three males name inscriptions (Jesus, Joseph and Yoseh) with one ossuary combining two names into the "Jesus son of Joseph" combination, and one female name inscription (Mary). Taking Yoseh as equivalent

[14]Rahmani's list in table 2 on pages 304-307 contains 126 tomb groups although only 63 of these contain ossuaries with inscriptions. Ilan lists additional ossuaries not in the possession of the Israeli Antiquities Authority, that came from other tomb groups. Possibly one-hundred fifty more or less is a reasonable figure for the total of discovered tombs containing ossuaries with inscriptions.

[15]Flanegan [7] lists all three of these tomb groups on page 370, but his list for the Talpiot Tomb contains errors in names. Tal Ilan [5] lists the Talpiot Tomb perhaps erroneously as being on the Mt. of Offense.

to Joseph for the moment to make the most conservative calculation, the probability of this particular group of names occuring in a six-ossuary group is[16] 0.00096 or 960 per one-million, and if we take the number of known tombs containing a sufficient number of ossuaries to actually accomplish this feat as thirty,[17] then we expect to find $30 \times 0.00096 \approx Zero$ such tombs; that is, it would take thirty times as many tombs as we currently know of to reach a reasonable expectation of observing one such set of inscriptions, even though many people believe, on the basis of name frequencies alone, that we should find not just one, but many tombs with such a group of names. Yet we do actually observe one such tomb, Talpiot, and one such tomb complex, *Dominus Flevit*.

To make this issue more clear, consider that the number of distinct combinations of three names at a time, using 447 distinct males names, and 74 distinct female names, is over one-hundred million, and the number of combinations in a six-ossuary tomb, like the Talpiot Tomb, exceeds a trillion. By comparison, there are probably around 150 known tombs containing inscribed ossuaries, Feuerverger assumes no more than 1100 of such exist in total, perhaps the actual number is as large as a few thousand, but in any case the number of actual tombs containing inscribed ossuaries is tiny compared to the possible combinations in the theoretical sampling distribution built from name frequencies. In other words, in contrast to the usual case in statistics where the actual distribution is fully populated and a sampling distribution provides a good approximation to it, the actual distribution in the case of ossuaries in tombs is very sparse. Probabilities and statistics in this case result from what groups of people actually existed and were entombed. Most name combinations have zero probability of occurrence because the combination of people never existed. Yet, at the same time some improbable name combinations are actually found in tombs. A theoretical distribution that realizes all possible name combinations possibly has little resemblance to the actual distribution; and, what is worse still, there is no obvious way to collapse the theoretical distribution into a more coarse measure that resembles the actual distribution better. Possibly Feuerverger's

[16]The probability calculation is that of obtaining two names from four ossuaries times one name from two ossuaries, which is $\frac{4!}{2!}(0.087 \times 0.038)(0.087)(0.91)^2 \times 2(0.213)(0.787) = 0.00096$ (960 in a million). If we wish to consider the rarity of the name Yoseh, however, we would change the probability for Joseph (0.087) to that for Yoseh (0.003) and the probability would fall to 0.000033 or only 33 in one-million!

[17]Rahmani's list contains 16 such tombs so perhaps there are 30 or so.

separation of combinations into two groups (nominal and alternative) is a productive step in this direction, but we have concerns about its correctness because of the complexity of finding which name combinations belong to the two categories.[18]

In effect, we have reasons to doubt that a sampling distribution built from names combinations using name frequencies has much resemblance to the actual distribution of name groups larger than two or three. Unfortunately it is larger name groups that are at issue here. We do not mean to imply that such theoretical calculations are useless, but only that one ought to use such calculations with due skepticism.

Other Jesus Family Tombs

Feuerverger's estimate of the name group in the Talpiot Tomb bearing a surprisingness of 1:600 leaves open a small possibility that other tombs may contain a similar list of names. Therefore, opponents conclude, this may not be such a significant find after all. In fact, recent postings on the internet discuss the necropolis known as *Dominus Flevit* which contains ossuaries inscribed with many of the Jesus Family names. Opponents of the idea that the Talpiot Tomb could be the tomb of the Jesus Family have siezed on this as an example of name groups similar to the Jesus Family being common among tombs. This is simply not so.

Having expressed skepticism about the utility of name frequencies for analyzing large groups of names, let us return nevertheless to the sampling distribution once again and calculate the probability of deriving the Talpiot tomb names from a random association of names in a hypothetical tomb with 43 inscribed ossuaries, the size of the tomb complex at *Dominus Flevit.* Once again the problem becomes complicated by other assumptions. We assume, for example, that the 43 ossuaries comprise 32 of males and eleven of females. The probability is then the product of two multinomial factors– the probability of two occurrences of Joseph and one occurrence each of Jesus, Judas, Matthew among the 32 males and one occurrence of Mary among the eleven females.[19] The actual calculation is then

[18]Feuerverger has submitted a detailed explanation to peer review which may settle all of these various concerns of ours. At present the description is just too sketchy to place unqualified confidence in it.

[19]We use two occurences of Joseph here because there is no "Jesus son of Joseph"

$$p = \frac{32!}{2! \ldots 27!}(0.087^2)(0.065)(0.039)(0.025)(0.700)^{27}\frac{11!}{1!10!}(0.213)(1-0.213)^{10} \tag{1}$$

which is 0.003. The equivalent calculation for the Talpiot Tomb is one each of Joseph, Jesus son of Joseph, Judas, Matthew among the four ossuaries bearing males names, and Mary once among the two ossuaries bearing female names. The numerical calculation is

$$p = \frac{4!}{1!1!1!1!}(0.087)(0.065)(0.0034)(0.025)\frac{2!}{1!1!}(0.213)(1-0.213) \tag{2}$$

which is 0.0000038. The ratio of the two is 783. In other words the *Dominus Flevit* necropolis, mainly by virtue of its size, is 783 times more likely to contain just one occurrence of these names than is the Talpiot Tomb. It is not reasonable to argue that *Dominus Flevit* is pertinent to an argument against the uniqueness of names in the Talpiot Tomb, when an extended tomb complex of its size is *a priori* 783 times more likely to contain these names than the Talpiot Tomb.

Data as evidence

We have argued that the number of possible combinations of names in tombs is vast and the number of actual names in tombs is small. The difference between the two is so great that the one may provide misleading guidance to the other. Classical statistical approaches are not going to resolve any argument in this situation. Rather we suggest another avenue of attack for reason that it gets directly at the heart of the issue.

Is the Talpiot Tomb the tomb of the Jesus Family? Ordinary statistics cannot take us to an answer of this question, but Bayesian statistics is of use here. Coincidentally, several other people have come to a similar conclusion. Randy Ingermanson has assembled two, well-written web documents that

inscription at *Dominus Flevit*, requiring an extra Joseph in order to make the two instances equivalent.

analyze the statistics of this issue, and which discuss the application of Bayes Theorem, but with which we take exception.[20]

Of the trillions of possible combinations of six names on ossuaries, nearly all will never occur in a tomb because no such family ever existed. To examine probabilitities from the flawed sampling distribution in this case makes little sense, and one ought to consider turning the entire problem around. Start with known facts, or at least with evidence that one can weigh in some manner, and then determine how this evidence should modify one's beliefs about the Talpiot Tomb. This is a Bayesian approach to the problem. What is especially appealing about using this approach is that it allows evidence other than just inscriptions to affect the outcome. However, in this brief section we will only make use of inscribed names to illustrate the use of Bayes Theorem.

For example, even though most possible name combinations never occur, there is one family that we know contained a Jesus, a Joseph, a Yoseh, and a Mary. Despite the coincidental occurrence of such a combination of names being extremely small, less than one in a thousand even without considering the rarity of *Yoseh*; and after examining less than two-hundred tombs, we find one bearing these names. Having observed this unexpected "evidence" of the cluster of names, how would a *Bayesian* statistician modify the *a priori* probability of this being the Jesus Family Tomb?

First we must assign an *a priori* probability ($P(A)$) itself. We know the Jesus Family existed, that Jesus died in Jerusalem and by Jewish custom was buried or entombed there, and that Mary and Jesus' brother James moved to Jerusalem where James became a leader of the early followers of Jesus. Some

[20]Ingermanson's two documents, [9] and [10], run across a large swath of statistical analysis and explain the issues well. Yet, his analysis is also consistently organized to discount the possible interpretation of the Talpiot Tomb as bearing the remains of the Jesus Family. For example, he states that the Talpiot Tomb contains the remains of as many as 35 persons; when in fact we are actually considering only six inscribed ossuaries no matter what else was in the tomb. This inflation of the number of individuals involved has the effect of suppressing the value of evidence as one can see from all of Ingermanson's graphs in [10]. As another example the interpretation of Matthew and Judah in the tomb as being disciples of Jesus, and from there assuming that any two disciples would be equivalent, has the effect of inflating the probability of finding an equivalent tomb because the names of the disciples Simon, Judas, John, Matthew, and James constitute a huge proportion of male names in use. In fact we have no evidence at all about the relationship of this particular Judah and Matthew to others in the tomb. Finally we see an over-reliance on elements of Christian dogma as fact.

portion of this family must have been entombed before 70CE. Therefore, a Jesus Family Tomb with ossuaries most probably exists somewhere in the Jerusalem area, *not in Nazareth*. The *a priori* probability of a randomly selected tomb being, in fact, the Jesus Family Tomb, is the inverse of the number of tombs in the area. Feuerverger implies *a priori* probability of about 0.001.[21] Perhaps the actual number is greater or less but not much so.[22]

Let A and B stand for a proposition and observation respectively. In this particular case the proposition of interest is $A =$*The Talpiot Tomb contains the Jesus Family* and $B =$*Observation of ossuaries bearing the noted names.* By Bayes' Theorem

$$P(A|B) = \frac{P(B|A)}{P(B)} P(A) \tag{3}$$

which we read in this instance as $P(A|B)$ =*the conditional probability that the Talpiot Tomb contains the Jesus Family given our observation of the six inscribed ossuaries in the tomb.* The probability $P(A)$ is the *a priori* probability of this tomb being that of the Jesus Family, we which just placed somewhere near 0.001. $P(B|A)$ is another conditional probability, which we feel is not difficult to calculate in principle, but which will require much input from scholars to calculate reasonably. It is the probability that a Jesus Family Tomb would contain these particular inscriptions on ossuaries.[23] $P(B)$ is a "normalizing" factor that represents the total probability of obtaining the observed names whether or not the family is the Jesus Family. It is easiest to calculate $P(B)$ using the *Law of Total Probability*, $P(B) = P(B|A)P(A) + P(B|\bar{A})P(\bar{A})$, where $\bar{A}$ is the negative of proposition A–in other words the

[21] Take the inverse of his 1100 trials, for instance.

[22] This business of *a priori* probability can be quite tricky. For example, Ingermanson in [9] makes an argument that there are possibly as many as 1008 men named "Jesus Son of Joseph" among the 80,000 or so men who lived in Jerusalem from 20BCE to 70CE. Since one of these is *the* Jesus, then his *a priori* probability is also about 0.001 once "Jesus Son of Joseph" turns up in a tomb. Yet, this calculation comes from a completely different consideration than does Feuerverger's. However, we also note that Ingermanson uses name frequencies that are much greater for the names Joseph and Jesus than those in Bauckman's compilations. For example, using Bauckham's [4] name frequencies we would calculate the number of men for whom "Jesus son of Joseph" is a true description as about 250, some four times lower than Ingermanson's figure.

[23] The more unreasonable critics are going to set this value to zero, but more realistically it has a finite value, and scholarship would provide it.

proposition that the tomb *does not* contain the Jesus Family.

We have actually calculated everything needed to apply Bayes' Theorem to this problem except for the conditional probability $P(B|A)$. Table 3 lists various possible sets of names one might expect to find in a Jesus Family Tomb, hence the list of all possible elements involved in $P(B|A)$. Not all possibilities on the list are equally likely to occur,[24] but let us assume each is equally likely for the moment. The actual observed set of names occurs only once on the list as combination number 17 and is then $\frac{1}{32}$ of the total probability. Therefore $P(B|A) = 0.0313$.

[24]For example *Jesus son of Joseph* and perhaps his mother is conceivably the most likely to occur and the combination involving *Mary* and all four of Jesus' brothers is least likely.

#	Names Involved	#	Names Involved
1	Jesus son of Joseph+	17	Mary+Yoseh
2	Mary	18	Simon
3	Mary+Simon	19	Simon+James
4	Mary+Simon+James	20	Simon+James+Yoseh
5	Mary+Simon+James+Yoseh	21	Simon+James+Yoseh+Judah
6	Mary+Simon+James+Yoseh+Judah	21	Simon+Yoseh+Judah
7	Mary+Simon+Yoseh	22	Simon+Yoseh
8	Mary+Simon+James+Judah	23	Simon+Judah
9	Mary+Simon+Yoseh+Judah	24	James
10	Mary+Simon+Judah	25	James+Yoseh
11	Mary+James	26	James+Yoseh+Judah
12	Mary+James+Yoseh	27	James+Judah
13	Mary+James+Yoseh+Judah	28	James+Yoseh
14	Mary+James+Judah	29	Yoseh
15	Mary+Judah	31	Yoseh+Judah
16	Mary+Judah+Yoseh	32	Judah

Table 3: A list of all possible combinations of significant names in a Jesus Family Tomb, using Mark 6:3 for his brothers' names. The '+' sign following *Jesus son of Joseph* indicates that it must be in all name groups, and the further numbered combinations are added to it. Obviously the fundamental name is *Jesus son of Joseph* as it is difficult to make a convincing case about a tomb without such an inscription. Not all combinations necessarily are of equal probability, and there may be other names suggestive of the Jesus Family that would expand the list–if we knew his sisters' names, for example. This is for purposes of example calculation only at present.

Since $P(A) = 0.001$ it follows that $P(\bar{A}) = 0.999$. $P(B|\bar{A})$ is just the probability of obtaining the four significant names using a random draw from the list of name frequencies. Using Yoseh as a form of Joseph we found this probability to be 0.00096 and using the more rare Yoseh itself we found this probability to be 0.000033. Therefore, using Bayes' Theorem and Yoseh itself we find ...

$$P(A|B) = \frac{P(B|A)}{P(B)} P(A) \tag{4}$$

$$P(A|B) = \frac{0.0313}{(0.0313 \times 0.001) + (0.000033 \times 0.999)} \cdot 0.001 \tag{5}$$

$$= 0.487 \tag{6}$$

In other words this Talpiot Tomb represents, by this calculation, a 49% probability of being the Jesus Family Tomb. This is much less certain than the misrepresented 599/600 of the *Jerusalem Post*,[25] but certainly worthy of sober, dispassionate research.

The unusual names

There are several names in the Talpiot Tomb that beg for explanation, and may be, in fact, key to eventually identifying the tomb names with a particular family. Certainly a valid route to identification is through unusual names. Feuerverger's calculation, for example, looks at two names in the Talpiot Tomb as being especially relevant. More significantly, though, Bauckham himself alludes to an analogous case. On page 47 of his book [4] he states

> Clopas is a very rare semitic form of the Greek name Cleopas, so rare that we can be certain that this is the Clopas who according to Hegesippus, was the brother of Jesus' father Joseph and the father of Simon, who succeeded his cousin James as leader of the Jerusalem Church.

One unusual name at Talpiot, inscribed in Greek, which Tal Ilan lists as *Μαριαμηνου* scholars working with the documentary translated as *Mariamne* "Little Mary". Though Mariamne is an appellation given to a Mary Magdalene-like person in Acts of Philip (fourth century CE), Pfann [1] considers this point irrelevant, being three centuries too late for legitimate consideration. Evans and Feldman [8] are even more emphatic about the irrelevance of this name.

[25] If one takes Feuerverger's 1:600 ratio, and also his estimate of about 1100 trial tombs in the Jersusalem area, then a logical implication is that this tomb has a 54% probability of being that of the Jesus Family. Interestingly, then, our figure is quite compatible with Feuerverger's conclusion eventhough the two are done from very different standpoints.

There are two other names that deserve mention. One ossuary bears the inscription "Judas son of Jesus." Depending on how one decides to interpret this inscription, and what one's prior beliefs are, this inscription alone could cause one to discount the Talpiot Tomb to be the Jesus Family Tomb altogether. The other is Matthew. There is absolutely no evidence at present to determine the relationship of either of these two persons to the others in the Talpiot Tomb.[26]

Significance of Yoseh

Perhaps the most significant name in the tomb is Yoseh. Some scholars lump this name with other forms of Joseph[27], but others, most notably Evans and Feldman claim the name Yoseh has nothing to do with Joseph and is a misrepresentation of Ilan's statement in the Discovery Channel documentary.[28]

The name Yoseh (YWSH) located on an ossuary in the Talpiot Tomb creates a number of problems. It appears to be a rare name; found in Talpiot, at Jason's Tomb and in the Murabbaat papyri.[29] Yoseh is considered by most scholars a variant spelling of Joseph (Yoseph=YWSF) and generally as a contraction of Joseph.[30] However, a highly negative article on the Talpiot Tomb and the name Yoseh appeared on the BAS web site titled, "Tomb of Jesus? Wrong on Every Count." Here the authors [8] insist that

[26]Although we could speculate that if the Talpiot Tomb does contain members of the Jesus Family, then "Judah son of Jesus" suggests that Jesus possibly had an illegitimate child, and just as occurs often in our own society, his mother, Mary, raised this child as a brother to Jesus as depicted in Mark 6:3. Another possibility follows a suggestion Rahmani made in his discussion of ossuary 706 from Talpiot; perhaps Mary in this tomb is actually Yoseh's wife and not Jesus' mother, and Matthew is the child of Yoseh and Mary–this doesn't invalidate the tomb as that of the Jesus Family. There are limitless other possibilities, but no facts, making these names neutral to the present issue.

[27]Bauckham [4] tabulates Yosi with Joseph, and Ilan [5] catalogs occurrences of Yosi and Yoseh with Joseph

[28]In fact a reading of Ilan's book [5] on page 159 produces the following footnote numbered 96 to the name Joseph "... Yoseh, Yosi, and Joseph seem to be variations on the same name". Therefore it appears that however she pronounces the name in the Discovery Channel documentary Ilan views Yoseh as a variant of Joseph.

[29]Ilan [5] page 152 for #89, page 154 for #133, and page 155 for #154.

[30]Ilan [5] page 23, section 2.4.1.1, note 232; Rahmani [6] page 223, ossuary 705; See Bauckman [4] who simply lists the Greek form Joses with Joseph on page 85 and does not make a distinction between the two.

> The name YWSH should be pronounced 'Yosah' (as Professor Tal Ilan in fact does in the documentary), not "Yoseh," as the documentary consistently does. "Yosah" is not the Hebrew equivalent of the Greek form Joses, the name of Jesus brother (as in Mark 6:3 and elsewhere). The Hebrew equivalent is YWSY (and is found on a number of ossuaries in Greek and in Hebrew). The documentary's discussion of this name is very misleading.

Pfann referring to the argument over Yoseh wrote

> A cautionary note on YWSH/YWSY point [YWSY=Yosi, a common form for the contraction of Yoseph]. Once we assess the sources, only YWSH can be attributed to the late Second Temple period [in] Judea and the Galilee (and which is basically true for the late Roman period as well). The only evidence for the pronunciation of vowels that comes from that period is from Greek forms of the name. There we only have "Iose/Ioses" and not "Iosah". Although this published claim is weak, we can, on the other hand, challenge the assertion of the filmmakers that this name is so rare. What comes down to us is in Greek. The Markan passage is unique with respect to providing this shortened Greek name for Jesus brother. However, in Greek inscriptions, the shortened form "Iose/Ioses" is more popular than "Iosepos".

And in another article on the net Pfann [2] stated that

> We really don't have any compelling evidence for the use of YWSY (Yosi), as opposed to YWSH during the Second Temple Period (or even for some time later). In the case of the Talpiot Tomb, YWSH should probably be pronounced "Yoseh" following the contemporary Greek pronunciation of that name (which preserves no examples of "Yosah").

James Tabor of the University of North Carolina at Charlotte has written that BAS got it wrong and that Yoseh is indeed the name found at Talpiot, is a very rare name, being found perhaps on only one other ossuary, and is most likely the equivalent of Joses the brother of Jesus found in Mark 6:3 .[31]

Furthermore Tabor [15] states that

[31] See Tabor's latest and most thorough discussion on Yoseh at [15].

> Much of the statistical work on the Talpiot cluster of names has been done using the nickname Yoseh as if it was the equivalent to the much more common name Joseph/Yehosef (8.6% of male names), which it plainly is not.

If we consider Yoseh as meaning more than merely finding the inscription "Joseph" on a ossuary, how does this change arguments based on probability? First, we occasionally use likelihood ratios to summarize our arguments as we did for comparing Talpiot to *Dominus Flevit*. In such a case the probability for Yoseh would occur in both the numerator and denominator of our likelihood ratio, and arguments based on it remain unchanged. However, when we calculate likelihood ratio when only one of the numerator or denominator contains probability for Yoseh, such as the likelihood of the contents at Talpiot compared to the most probable tomb; or, when we calculate probability of occurrence of a name combination, or multiply such a probability by the numbers of tombs in order to arrive at an expected number of observations, then the name Yoseh is so rare that it changes probabilities and expectations by a factor of about 29. Obviously such a large change in probability means that observing the name Yoseh is very much more significant than observing the name Joseph in any tomb suspected of containing remains of Jesus' family members. For example, if we repeat the calculation using Bayes' Theorem that we made in Equations 4 through 6 using the name Joseph rather than Yoseh, the probability $P(B)$ becomes 0.0010025 and the *a posteriori* probability falls to around 6%. This is only one-eighth the value (49%) obtained using Yoseh in the calculation. So we might say that observing the name Yoseh is eight times more significant as a piece of evidence regarding the Talpiot Tomb being the tomb of Jesus' family than is observing the name Joseph.

Jesus of Nazareth vs. Jesus son of Joseph

Another argument voiced by critics of the Talpiot tomb is that Jesus is known in the Gospels as "Jesus of Nazareth" and not "Jesus son of Joseph" as inscribed on the ossuary uncovered at Talpiot [8]. The claim that an ossuary holding the remains of Jesus would not be inscribed with *Jesus son of Joseph* is not supported by statistics of the ossuaries catalogued by Rahmani. Out of the 227 ossuaries recorded in Rahmani about half of the inscriptions refer to the deceased and their kinfolk, and there are "...seventy-three inscriptions

that refer to the father of the deceased".[32] Very few ossuaries are inscribed with the names of the deceased person's birthplace or hometown. Indeed, there are only six such ossuaries inscribed with origins or birthplace listed in Judea or its immediate environs.[33] There are nearly twice as many ossuaries that are inscribed referring to women and the names of their husbands, than those mentioning local origins.[34] Statistically, ossuaries are far more likely to refer to the deceased persons nickname than their local origins. Nicknames include 'the dour,' 'the amputated,' 'the mute,' or 'strong,' 'beetle-browed,' 'the small,' 'grasshopper,' 'the fat or stout,' and 'one-eyed.'[35] Of the 43 inscribed ossuaries at the large necroplis uncovered at *Dominus Flevit*, none bear and inscription indicating origins from Judea or its immediate environs. There may be two ossuaries inscribed in Greek mentioning Crete and Cyrene [11].[36] Lack of ossuary inscriptions including place names at *Dominus Flevit* is exactly what we would expect based on Rahmani's work. In effect, place names on ossuaries are so rare among observed inscriptions that "Jesus son of Joseph" is some twelve times more likely to occur as an inscription than "Jesus of Nazareth."

Furthermore, several scholars have noted that Rahmani has argued that "the deceased's place of origin was noted when someone from outside Jerusalem and its environs was interred in a local tomb." Magness [14][37] pointed out

> If the Talpiyot tomb is indeed the tomb of Jesus and his family, we would expect at least some of the ossuary inscriptions to reflect their Galilean origins, by reading, for example, Jesus [son of Joseph] of Nazareth (or Jesus the Nazarene), Mary of Magdala, and so on.

[32] Rahmani [6] page 15.

[33] Rahmani [6] on page 17 lists the following ossuaries with birthplaces and/or hometowns: Beth Shan/Scythopolis, #139; Sokho, #257; Beth Alon, #293; Beth Ezob, #797,803; Jerusalem, #777. Rahmani lists Bethel with no ossuary number.

[34] Rahmani [6] page 17. There are only a few locations outside Judah referred to on other ossuaries such as Berenike in Cyrenaica as a possible location, #404; Ptolemias, possibly Cyrenaica, #99; Hin in Babylonia or near Caesarea, #290. There are a number of ossuaries inscribed with a name that scholars suspect are common to Egypt or Cyrenaica. These place names are too speculative to be regarded as evidence of origins, and cannot be considered in the same category as inscribed place names.

[35] Rahmani [6] page 17, IAA ossuaries numbered 44, 62, 117, 288, 421, 498, 579, and 822 respectively.

[36] We thank our colleague, Pat Landy, for these Greek translations.

[37] Tabor's essay on Magness is available at [16].

We find very little evidence for this conclusion. In Rahmani's Catalogue there are only three inscribed ossuaries located in Jerusalem tombs referring to origins from Judea or its environs.[38] The paucity of inscribed ossuaries indicating origins uncovered in Jerusalem tombs does not sustain the claim that only Jews living outside Jerusalem inscribed their place of origin. As we have mentioned above, statistically, an inscription like "Jesus of Nazareth" would have been exceedingly rare. Jesus son of Joseph matches the archaeological evidence uncovered in the tombs of Jerusalem. More data is needed to support Rahmani's claim concerning the deceased's origins.

Conclusion

While we are unsure of the correctness of Feuerverger's approach to statistical analysis of the Talpiot Tomb, we do agree with his conclusion that the Talpiot Tomb is significant by virtue of its improbability. One way to demonstrate this is to calculate the probability that such a small tomb, with only six inscribed ossuaries, would contain either no name from Jesus' family or only one name. Taking Yoseh to be a rare name, and not just another form of Joseph, this probability is over 70%. In other words the odds of a tomb like the Talpiot Tomb containing either none or only one name from Jesus' family are 7 to 3. Instead the tomb contains four name references, identifies Jesus with his correct father, and contains possibly the rare form of Jesus' brother's name. It is even more specific in pointing toward members of Jesus' family than is the much larger necropolis *Dominus Flevit*.

We have also noted the large amount of erroneous arguments and statistics unleased to trivialize this tomb as an archeological find. Much of this criticism is simply *ad hoc*, sometimes has no basis in fact, and is often thin on logic.[39] We feel this tomb is a significant find and worthy of whatever other scholarly and research efforts could prove its identity.

[38]Rahmani [6] page 17. The number may be less. Sokho's provenance #257 is listed as 'Jerusalem?'.

[39]If one were to find a tomb in the area of Virginia City, Nevada, with inscriptions like *Ben, Adam, Little Joe son of Ben, and Hoss*, one would not expect hysteria over claiming to have found the Cartwright's tomb. Yet such expectation seems a certainty with the Talpiot Tomb.

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