THE TRUE ARCH: AN ABSENT TRAIT IN PRECOLUMBIAN AMERICA?

by

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Summary

The true arch is said not to have been known to the ancient high cultures of PreColumbian America. Evidence is sought to determine whether this is true.

Introduction:

IN A PAPER published in 1971 that considered a wide range of theoretical and methological issues relating to the diffusionist problem, Stephen Jett (Professor of Geography, University of California, Davis) observed the following:

'An argument frequently used in support of the isolationist viewpoint is that, if significant contact had occurred, important Old World culture traits missing from the Americas would have been adopted in the New World. Art historian George Kubler writes: "The diffusionists have never given any explanation of the absence of large-wheeled vehicles and of Old World beasts of burden in America. Would these powerfully useful instruments not have survived the displacement more readily than Hindu and Buddhist symbols?" Other significant absences have been discussed. Kroeber, though not arguing this point specifically, also lists proverbs, divination from viscera, ironworking, stringed instruments (other than the monotone bow), and oaths and ordeals as not present in the Americas. The true arch, draft animals, the plow, milking, the potter's wheel, and coined money have also been mentioned, and other traits, such as glassmaking and the crossbow, could be added.'[1]

JETT GOES on to point out that, in actual fact, not all of the traits listed above *are* missing in the Americas. He also cites various examples as evidence. However, in this paper I wish to deal solely with the true arch, and to endeavour to determine whether this particular construction technique was indeed absent, as is very often stated, in PreColumbian America. Before we discuss this important topic in depth, it is necessary for us to be totally certain of precisely what is meant by the term "arch" Primarily, it is important to understand that an "arch" refers to a construction technique as employed in monumental architecture. We are not referring to a simple post-and-lintel doorway, or to a naturally occurring structure that has been

used, or in some way modified by man to serve as an arch. Therefore, our discussion is confined purely to those ancient high cultures of both the Old and New Worlds that designed and built monumental constructions and were faced with the problem of spanning the space between walls, piers, or other supports in order to create a roof or ceiling. In order to achieve this, only two techniques are possible. One method is to construct a so-called "true arch", and the other method is known as constructing a so-called "corbeled arch".

IN ORDER TO determine the difference between the true and corbeled arch; let us first consider the construction technique of the true arch.

The True Arch:

The true arch **(Figure 1)**, also known as the round arch, semicircular arch, masonry arch, and the Roman arch, is basically a rigid span curving upwards between two points of support such as walls or piers. The points from which the curve rises from its vertical supports are known as springs. The curve itself consists of wedge-shaped blocks of stone or brick called voussoirs that press against one another for support. The central voussoir is known as the keystone. The stresses in the true arch tend to squeeze the voussoirs outward in a radial manner, and loads divert these outward forces downward to exert a diagonal force, called thrust, which can cause the arch to collapse if it is not buttressed. One of the principal advantages of the true arch is the extremely wide span that can be achieved. Indeed, it was originally developed to connect a greater distance between two supports than a single horizontal beam, or lintel, could bridge.

The true arch was, in all probability, invented in Mesopotamia during the 4th millennium B.C.. It was known to many ancient societies of the Old World including the Sumerians, Egyptians, Babylonians, and Greeks, but was considered unsuitable for monumental construction. Although the Assyrians built palaces with arched ceilings, true arch construction was never fully exploited by the ancient peoples of the Old World, and it was generally used for secular structures such as storerooms and sewers. For instance, the Etruscans employed true arches in drains and tombs, but never used a true arch to span a wide space in monumental building construction. The Romans, in contrast, were the first to develop the true arch on a massive scale. They engineered it to perfection and used it in structures such as amphitheatres, palaces, and aqueducts. In many cases the Romans did not use mortar, but relied on the precision of their stone dressing. Subsequent developments in later ages, including the pointed, scalloped, horseshoe, and ogee (S-curve) arches for mosques and palaces, are really elaborate variations upon, what is essentially, a true arch construction technique.

A SERIES of true arches can be connected together, so to speak, to form a roof or ceiling for a room. When this occurs it is known as a barrel (or tunnel) vault. A major difficulty when building a true arch or barrel vault is the fact that a temporary supporting structure must be erected within the vaulted area during construction. This is due to the fact that a masonry vault does not become self-supporting until the central voussoir (keystone) is put in place.

A dome is a spherical vault resting on a circular base wall.

The Corbeled Arch:

The corbeled arch **(Figure 2A)**, sometimes known as the false arch, is far easier to construct than the true arch. A corbeled arch has the shape of an inverted "V". It

consists of a series of stone blocks on

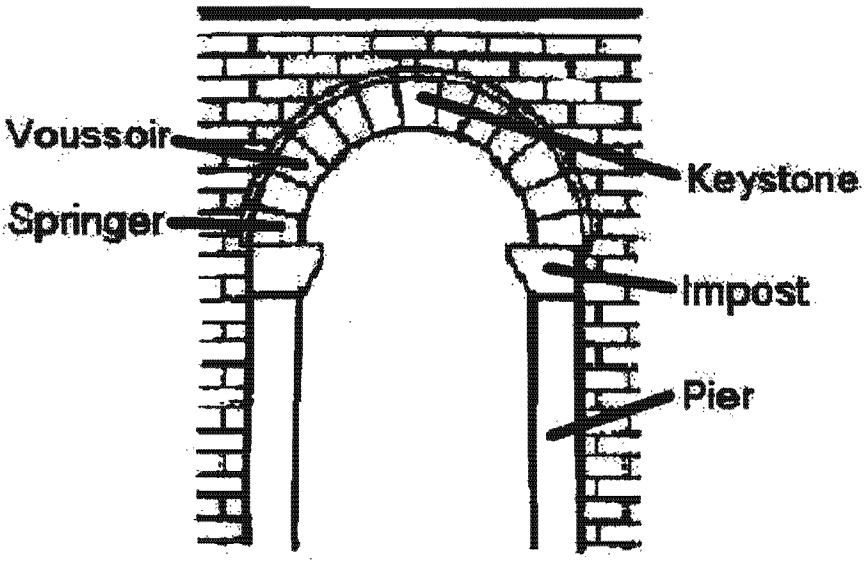

Figure 1: Diagram showing a true arch and its basic components.

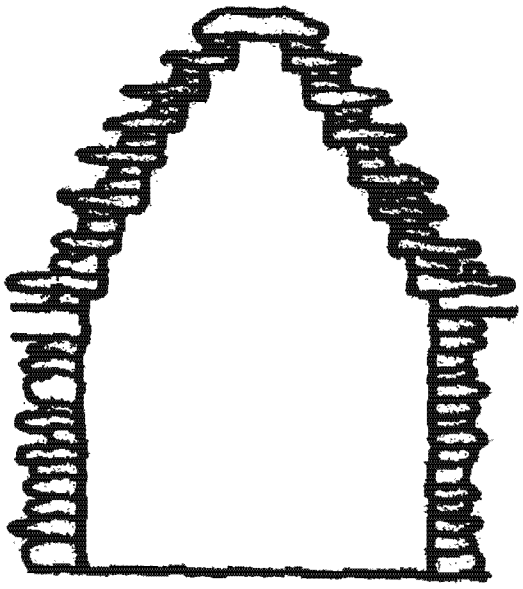

Figure 2A: Diagram showing a corbeled arch comprised of blocks of stone piled one upon the other. Each successive block projects further inward until the intervening space between the walls can be finally bridged by a single block known as a capstone.

Figure 2B: Maya corbeled arch at Kabah, Yucatan, Mexico. Corbeled arches such as this are found throughout the Maya region. They are a hallmark of Maya architecture.

Photo: D. Eccott.

either side of an opening in a wall. As the blocks are piled one upon the other, each one projects further inward than the one below until the intervening space between the walls can be finally bridged by a single block known as a capstone. Unlike the true arch, which is an integrated unit because each block forming the curve is supported by the blocks on either side of it, the only support in a corbeled arch is from the overlap of the block below. The corbeled arch is therefore considered to be much weaker than the true arch.

IT IS ALSO possible to construct a corbeled vault to provide roofing for a room. However, because of the weaknesses inherent in corbeling, thick walls are necessary. Furthermore, the span of a corbeled arch or vault is extremely limited and rarely exceeds 10 ft.

The corbeled arch was known and used by various Old World societies. As early as 2000 B.C. corbeled arches were being constructed by the people of the Indus Valley. At Harappa, for instance, a magnificent corbeled arch was excavated below a gateway in a major city street. It had been used to dispose of rainwater and sewage. However, it was in the New World the corbeled arch became a hallmark of the Maya who used it extensively in the construction of their palaces and temples, etc. Indeed, the corbeled arch was a fundamental concept of Maya engineering. **(Figure 2B)**.

Implications of the Apparent Absence of the True Arch in PreColumbian America:

It is often stated outright that true arches, and (by extension) barrel vaults and true domes, were not known to the high cultures of the PreColumbian societies of the New World, and that the complex construction of the true arch was not understood by such peoples. Despite this, there have been many claims that the true arch did exist in PreColumbian America. Some claims must be treated with caution because inexperienced observers have become confused over the term "round", which is one of the terms that is sometimes applied to the true arch. The corbeled arches and vaults of the Maya were often either thickly plastered or constructed with bevelled stone in order to produce a smoothed soffit, giving the underside a smooth semicircular appearance. The famous trilobate arch at Palenque **(Figure 3A)** is a case in point. It has the smooth, rounded appearance of a true arch, but scrutiny of its inner core **(Figure 3B)** reveals that it is, in fact, not a true arch, but a corbeled arch.

AS WE HAVE already seen, the absence of the true arch in PreColumbian America is used by some to argue that contact did not therefore occur before the time of Columbus. They presume that, if contact had occurred, the knowledge of true arch construction and the greater benefits that it afforded would have been imparted to New World societies and used in their architecture. Before we continue to search for evidence of true arch construction in pre-conquest Mexico, let us examine the question of whether the apparent absence of the true arch in PreColumbian America can really be taken as evidence that PreColumbian contact between the Old and New Worlds did not occur.

In the aforementioned paper,

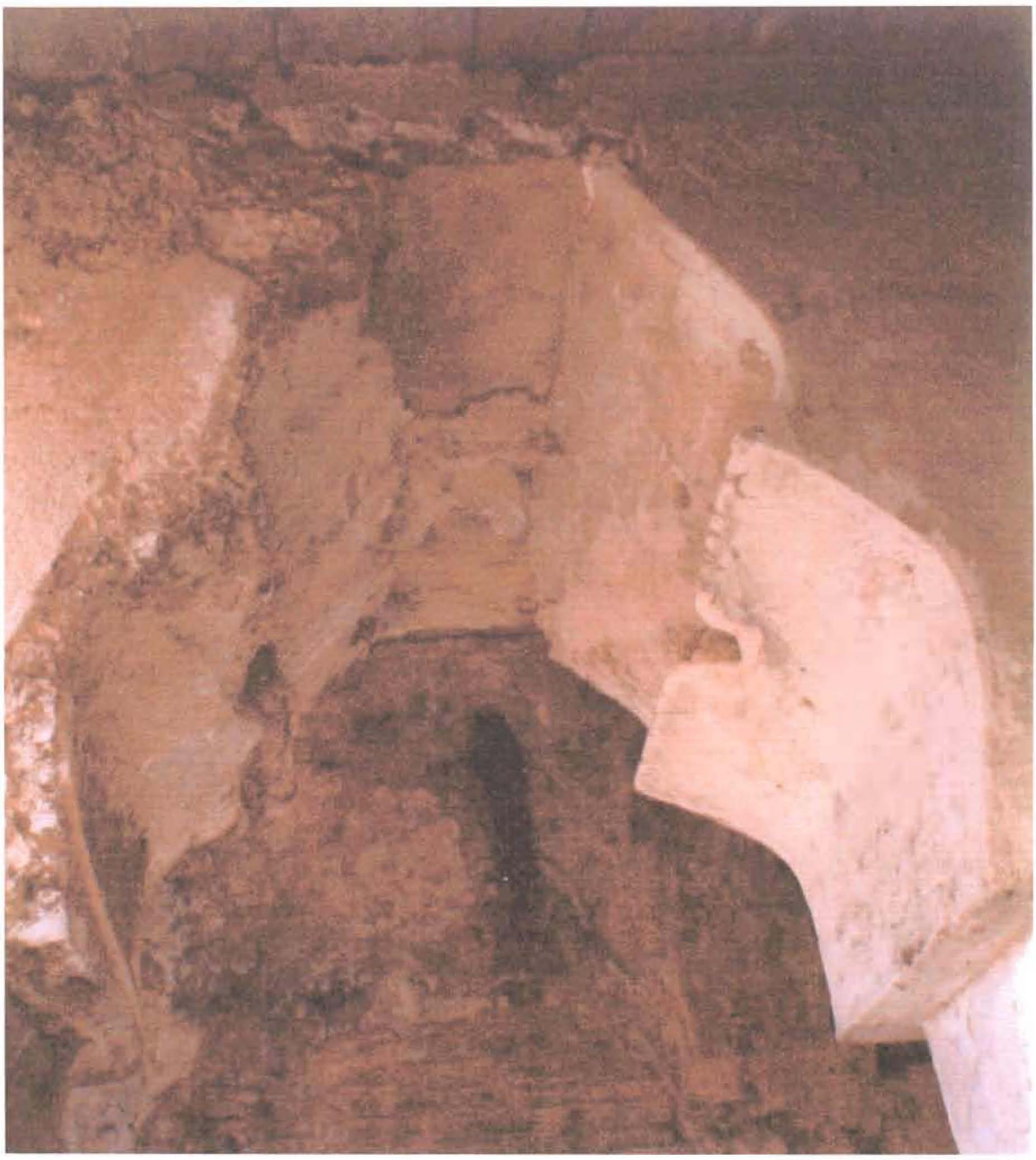

Figure 3A: Trilobate arch at Palenque. Although it has the smooth, rounded appearance of the true arch, it is a corbeled arch.

Photo: D. Eccott.

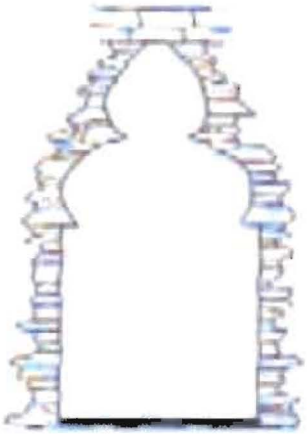

Figure 3B: Diagram showing inner core of the trilobate arch at Palanque, which reveals ist corbeled construction.

Stephen Jett also considers this aspect. He points out that absences are not considered decisive by diffusionists and quotes Ekholm as saying 'What is selected (from a donor culture) is dependent upon a multitude of factors that combine in numerable ways, so general rules of how it can be expected to work in any given situation are almost impossible to make.'[2] Jet also quotes Heine-Geldern who dealt specifically with the problem of the true arch, drawing attention to the fact that 'The absence of the true arch in America is often stressed by Americanists. They obviously believe that that the (true) arch was known in eastern Asia since hoary antiquity. Actually it became known in China only at the time of the Han dynasty [205 B.C. to A.D. 220].... Again.... it was never adopted by the peoples of Champa [in Annam], Cambodia, Java, etc., who were in close contact with the Chinese.'[3] In short, it is known that many ancient Old World peoples were aware of, and able to construct the true arch, but rejected it because they considered it unsuitable. Therefore it could be argued that the trait (in this case, *rejection* rather than *adoption*) was the one that was conveyed through contact. Furthermore, in southeast Asia, the area from which many scholarly diffusionists consider that the main thrust of Old World influence upon the high civilizations of the New World originated, temple centres were constructed with corbeled arches until the fifteenth century A.D.. Therefore, if indeed contact was made between the Maya world and southeast Asia, it is hardly surprising that the corbeled arch, rather than the true arch, might have been the method that was diffused to become a fundamental construction technique of the Maya.

Even so, this still leaves the question of

whether ancient American peoples, such as the Maya, were indeed aware of, and able to construct, the true arch. Many of the leading publications on the Maya, such as those by Morley, Brainerd, and Sharer,[4] and Michael Coe,[5] simply do not even mention the true arch. It is ignored because, one presumes, these authorities know that the true arch did not exist in Maya monumental construction. Other authorities, such as the author of a recent book on Maya monuments,[6] inform us quite categorically that the Maya did not use, and were unable to construct the true arch. In the same breath the author also states that this was also true of the ancient Greeks. We already know that this is inaccurate, but what of the Maya?

A CURIOUS statement appears in GallenKamp's *Maya*[7] Whilst considering certain basic concepts of Maya construction techniques, Gallenkemp writes '....temples and palaces, with their interior space and vaulted rooms, presented complex problems involving balance and stress, and the use of corbeled arches in place of the true arch (*which the Maya never perfected*) required unusually thick walls to support the canti-levered blocks that formed the vaults'. (Italics added). Gallemkamp, rather than stating that the true arch was completely unknown to the Maya, seems to be implying that it was, after all, known to them, but that they simply did not perfect the technique of true arch construction. Unfortunately, Gallenkemp provides no further information on the topic. However, Dr. Alice Beck Kehoe goes even further and states that 'in fact, three true arches are known from the Maya Late Classic.'[8] But, once again, no information on where these true arches are to be located is provided. In an attempt to learn more, I contacted Dr. Kehoe in 1999. She kindly replied to my letter and informed me that it was Gordon Ekholm who had told a conference (on PreColumbian transoceanic contacts) in 1977 that three true arches had been recognized from PreColumbian Mexico, but that her notes from the conference did not contain any further details on his statement.[9] The two contacts that Dr. Kehoe suggested might be able to provide details were also unable to help. At about this time an entry in *Pre-Columbian Contact with the Americas across the Oceans: An Annotated Bibliography*[10] provided the answer to the possible location of one of the true arches in Mexico. The entry in question (B-141) made mention of a paragraph in *Current Anthropology* and an unmistakable true arch at the Maya site of La Muñeca.

La Muñeca:

IN 1963 a gentleman by the name of Harumi Befu wrote to the prestigious American journal *Current Anthropology* requesting clarification of a slide (numbered K7901) from the Slide Library of the American Museum of Natural History. The slide apparently showed a crude true arch in the interior of the Sweat Bath at the Maya site of Chichen Itza. Befu wished to know how the Maya had constructed a true arch when courses in anthropology taught that the true arch did not exist in PreColumbian America. He said that he would appreciate comment from a Mesoamerican specialist concerning the matter. The editor of *Current Anthropology* sent Befu's letter to Dr. Gordon Ekholm of the American Museum of natural History, and in October 1964 published Befu's letter and Ekholm's response.

DR. EKHOLM was aware of the slide referred to by Harumi Befu. He explained that it was one of a large series of Kodachrome photos of Maya sites and architecture made by Mr. Bruce Hunter of the Department of Education of the American Museum of Natural History. Ekholm confirmed that the slide showed the interior of the Sweat Bath, Structure 3E3 at Chichen Itza, which was excavated by the Carnegie Institute in 1936. He further explained that the apparent true arch shown in the photograph was, almost certainly, an error made during the reconstruction of the Sweat Bath, adding that 'although the American Museum photograph does show what exists at present at Chichen Itza, it mistakenly implies that a true arch was discovered in the structure'. In other words, the Maya had not originally constructed a true arch at Chichen Itza. However, it is in the following paragraph of Ekholm's reply that the interest really mounts. For this reason, and because Ekholm discusses some thought provoking issues, I shall now provide the remainder of Ekholm's response, quoting it in full. Ekholm continues:

'While Chichen Itza does not provide the example to prove incorrect the often stated "rule" - that the true arch was unknown in the New World - there is fairly good evidence that the principle was understood and applied at least once by the Maya. This occurrence is in Structure XII, Room 2, at the site of La Muñeca in southeastern Campeche, that was discovered by a Carnegie Institution survey of the region in 1933 (Ruppert & Denison 1943: 8, 25-26, Fig. 22, 23, plate 3, 4A).[11] The vault was incomplete, unfortunately, but the evidence leaves little doubt that a true arch is indicated. Section and elevation drawings taken from Fig. 22 and 23 of the report are reproduced here. (See **Figure 4A & 4B** for reproduction). The brief but revealing description of the building is as follows:

"THE MOST interesting feature of this building is some strong slabs, which formed the vault and are still in position on the north wall. These slabs, of which a great many were also seen in the debris, average 50 cm long and 25 cm wide. In section they are wedge-shaped, being 8 cm thick at one end and 5 cm thick at the other. Those of the first course have their exposed ends in line with the face of the wall and incline upwards towards the unexposed ends. Each subsequent course overhangs the one below and the slabs are placed at a greater angle. Seven courses were found *in situ*. A section of the vault on which plaster still remains suggests that the finished surface was a smoothed curve (Ruppert & Denison 1943:26)"

'It is possible, of course, that these features of the building at La Muñeca can have some other explanation than that they represent a building roofed with a barrel vault constructed in the manner of a true arch, but that seems to be the best interpretation of what was found. In considering the evidence, it is most important to remember that those who discovered and described the building were not amateurs. They were experienced students of Maya architecture who were

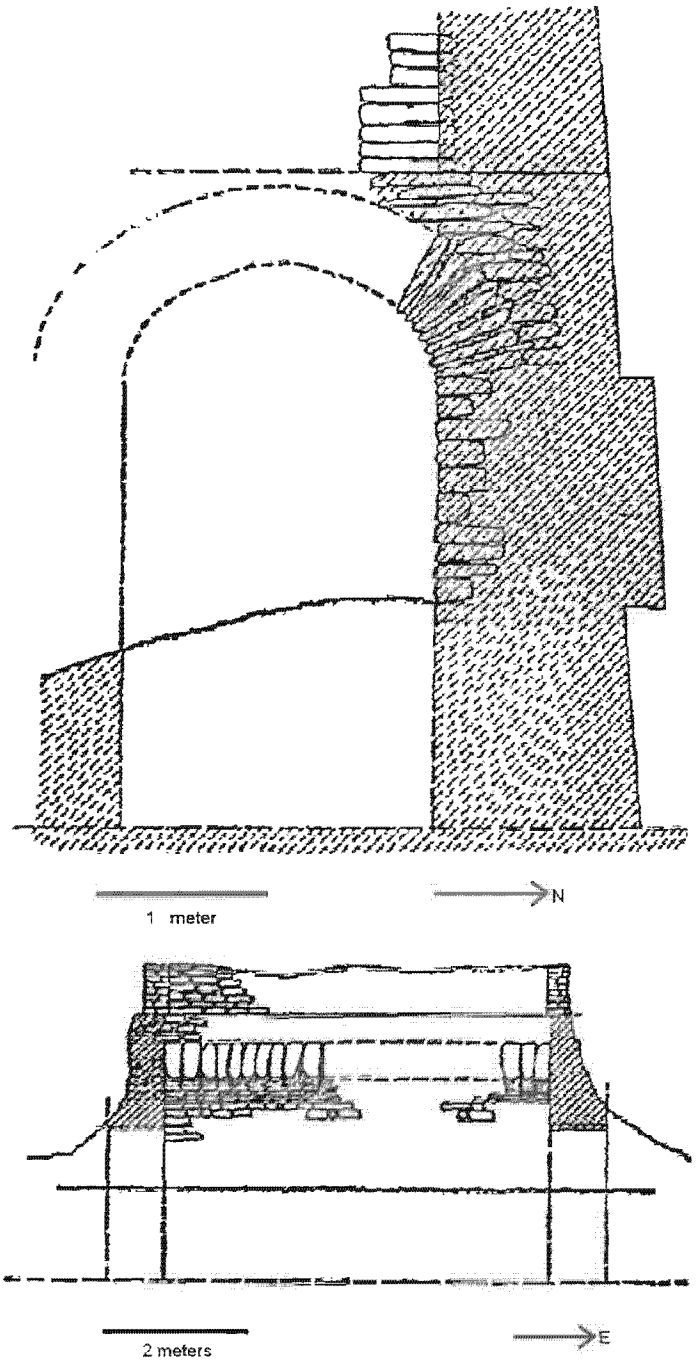

Figure 4 A: Section and elevation drawings of the arch and vault at the Maya site of La Muneca. This clearly reveals that the arch is "true" and not corbeled. Compare with the corbeled arches shown in Figures 2A & "B in order to observe the structural differences.

Tracing by D. Eccott from the original drawing by Ruppert and Denison.

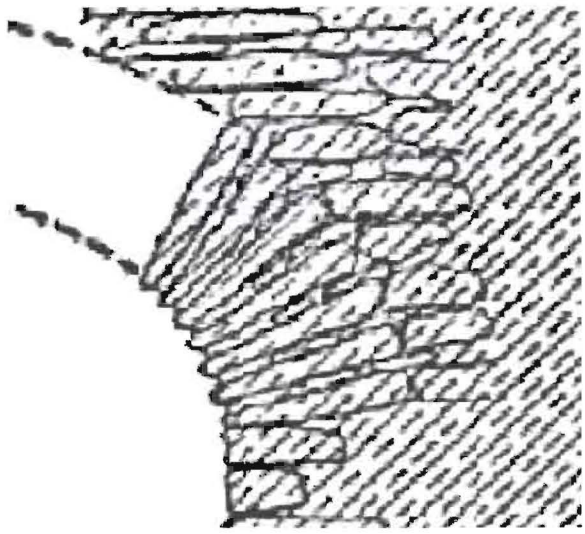

Figure B: Enlargement of a portion of the drawing in Figure 4A showing wedge-shaped blocks that form the curvature of the arch. This is the method of construction for a true arch as shown in Figure 1. Notice that some form of mortar seems to have been used, rather than relying on the precision of stone dressing alone, as was the case with pre-Roman cultures of the Old World.

well acquainted with all its variations, and it is probably fair to say that they were predisposed toward finding nothing more than the usual variations. They nevertheless made and published the drawings we see here and interpreted what they saw as an example of a true arch.

'This quite convincing evidence for the existence of a barrel vault in a building of the late Classic Period in the Central Maya area is of special importance for two reasons. The first and most important is that it raises the basic questions about the presence and origin of a trait that is usually considered to represent a major step in the approach to civilization. Did the Maya in the course of their extensive experience in the construction of stone and mortar roofs discover by chance or through intentional experimentation the principle of true arch construction? Or is this a trait that must be listed among those that give some indication of influence from the extra-American civilizations? Second, why is it that this seemingly good evidence for the ancient Maya having known the true arch was published over twenty years ago and since that time has been scarcely mentioned? Its significance has not been discussed and it has not been mentioned or considered in connection with any of the more general discussions of Maya culture or American civilizations. As Befu's query indicates, we

all continue to learn that the true arch was unknown in the Americas. The interesting question of why this should be so deserves extensive treatment, but such will not be attempted at this time.

'ASSUMING, as I tend to do, that the ruined building at La Muñeca does indicate that, at one point in their history, the Maya built a true arch, I am quite uncertain as to how to interpret the situation. In my mind it is perfectly conceivable that in the Maya area, where many thousands of vaulted roofs must have been constructed during the period of at least 10 centuries during which they seem to have been popular, someone might have invented and produced a true arch quite different in principle from the standard corbelled vault. The form may have achieved some local popularity and have been used a number of times before it was discarded. By chance only one example has been partially preserved and discovered. Because of my interest in the question of trans-Pacific contacts, I would be more inclined, however, to consider this a trait that may have been introduced from outside. Few will agree with me, perhaps, and I cannot present here a full argument for my view. I will only remark that we have been too prone to expect that any influence from outside the Americas must be completely obvious and unequivocal, while the probability is that the presence of such traits can only be discovered through extensive search for them. It is possible that knowledge of the true arch could have been introduced and was applied for a time in one region before it succumbed to the more established tradition of building corbelled vaults. We cannot assume that the true arch was more efficient or desirable than the corbelled arch, nor that it would necessarily become predominant if it had been invented by the Maya or introduced to them. It is well to remember in the connection that at Angkor in Cambodia it was only the corbelled vault that was used although knowledge of how to construct the true arch was undoubtedly available to the Khmer architects.

'In short, the true arch probably was used at least one time in pre-Columbian America. **One result of this conclusion is that it is no longer admissible to use its supposed absence here as an unqualified cornerstone of the argument, as is often done, that the New World civilizations were completely independent from those of the Old World.**'[12] (Emphasis added).

THERE IS no question that the Muñeca arch was modified in some modern attempt at reconstruction, as was the arch at Chichen Itza. Neither is there any possibility that the arch was the result of rebuilding by the Spanish after the conquest, as there is absolutely no evidence of Spanish activity at the site. Furthermore, the building in which the arch is set has an outer wall that was (at least at the time of the Carnegie Institution Survey in 1933) well preserved, and was complete with cornice and roof-comb base typical of Classic period Maya architecture. In the words of Satterthwaite, '....the Maya at La Muñeca roofed a long room with the true arch, and they knew exactly what they were doing.'[13] It would appear that the true arch at La Muñeca was certainly one of the three true arches that Ekholm said had been recognized from PreColumbian Mexico. But, where are the other two?

The Fortress of Oztuma in Northern Guerrero:

In 1966 *Current Anthropology* published a letter by Karl H. Schwerin.[14] Schwerin had

read Ekholm's remarks in the 1964 issue of *Current Anthropology* and now suggested that there was evidence that the true arch was used in at least one other part of pre-conquest Mexico. He stated that various authorities, when describing the site of Oztuma (located 23 miles west of Teloloapan, Guerrero, in the municipality of Acapetlahuaya), referred to a 'perfect arch with voussoirs and key,' Early colonial records indicate that the fortress and temple were constructed by the Aztecs shortly after their conquest of the region. *Current Anthropology* again published a response to Schwerin's letter by Gordon Ekholm[15] who agreed that he should have mentioned this occurrence of another true arch in Mesoamerica in his previous comment.

SOME AUTHORITIES have, apparently, argued that the arch was constructed by the Spanish but, as Schwerin points out, 'the fact that there are no other Spanish structures at the vicinity, and no evidence that the Spanish ever occupied the site, supports its being of Aztec construction.' Also this particular arch, although apparently true, was a somewhat crude form of a true arch. Photographs by Hendrichs[16] revealed inherent weaknesses in the construction that had caused the keystone to slip out of place. It is highly unlikely, not to say impossible, that Spanish masons, skilled in true arch construction, would have constructed a true arch with inherent weaknesses causing undue stress and insecurity to the structure. Although built 800 years after the Muñeca arch, and perilously close to the Spanish conquest, we can however state with reasonable confidence that the Oztuma arch comprises another example of true arch construction in PreColumbian America.

True Arches at Nakum?

ANOTHER REPORT of a true arch in the Maya area of PreColumbian America comes from Alfred Tozzer. Like Ruppert and Denison who penned the report concerning the true arch at La Muñeca, Tozzer was not an amateur, but an experienced student of Maya architecture, well acquainted with all its variations, and not predisposed toward finding anything more than the usual variations. Alfred M. Tozzer was Professor of Anthropology at Harvard University, and an authority on numerable aspects of Maya culture. Apart from writing books on Maya grammar and translating Landa's *Relacion de las Cosas de Yucatan*, he also undertook pioneering ethnographic work among the Lacandon Maya. Tozzer trained a generation of Maya archaeologists, and excavated Tical and Nakum.

The central lowland Maya site of Nakum is located in Guatemala, southeast of Tikal. It was first reported to the outside world by the explorer Maurice de Perigny in 1906, and preliminary studies and excavations of the site were made by Tozzer in the early 1900s. Tozzer published his report on Nakum in 1913, and it is in this report that Tozzer make reference to a true arch. The core of Nakum is composed of two large architectural complexes connected by a sacbe. The southern group contains a structure that has been designated Temple A. This particular temple has a central doorway with a wooden lintel that is flanked on either side by two arched openings. Tozzer refers to these arched openings as 'two lateral doorways' which is confusing, considering my earlier statement that a simple post-and-lintel doorway does not constitute an arch. The term doorway, as

applied by Tozzer, refers to the two lateral arches, which should not be confused with the simple, straightforward central doorway). Tozzer writes as follows:

'THERE ARE TWO examples which seem to show the nearest approach to a true concrete arch yet found in the Americas, the two lateral doorways in Temple A. By a close examination of the masonry it seems impossible to believe that these could have been constructed without some temporary wooden form....

'The method of bridging the three doorways (at Temple A) is interesting. The middle door (six and a half feet in width) is spanned by five massive sapote beams. The two lateral doorways (10' 6'' in width) have what may be truthfully called concrete arches. They are the first and only examples of the true arch that I have met with in Maya buildings. They are by no means uniform in their curve. The slope is rather uneven, especially in the northern opening. As already pointed out, it does not seem possible to have built these without some form of temporary wooden support.'[17]

It seems most improbable that an experienced archaeologist and student of Maya architecture such as Tozzer would mistake a true arch for a corbeled arch. However, in *The Ancient Maya* by Morley, Brainerd, and Sharer,[18] it states that 'Temple A is noteworthy as having two **unusual corbel-vaulted doorways** flanking a central doorway with a wooden lintel'. (Emphasis added). So, it seems that there is a contradiction here, with Tozzer describing the openings that flank the central doorway as 'two examples which seem to show the nearest approach to a **true concrete arch**', and Morley, Brainerd, and Sharer describing them as **unusual corbel vaults**. It must be said that the latter description rather begs the question as to what is so "unusual" about these (apparently corbeled) vaults. After all, as previously noted, any development or elaboration can only be purely cosmetic. The basic construction of an arch can only be either "true" or "corbeled". It is impossible for the fundamental concept of either to be "unusual" in any way. Unfortunately, Morley & Co. do not elaborate further, and one wonders if the term "unusual" is a means of sidestepping the issue so as to avoid having to state that the arch was "true" - a feature not supposed to occur at a Maya site. It would also be appropriate to ask whether any of the authors of *The Ancient Maya* are speaking from first-hand knowledge of the site. The first edition of *The Ancient Maya* by Sylvanus G. Morley was published in 1946, and the second, with revisions by Morley himself, was published in 1947. A third edition, published in 1956 was prepared after Morley's death by George W. Brainerd. The publishers state that subsequent editions by Robert J. Sharer preserve as much as possible the original Morley-Brainerd text. As the passage in question has remained the same throughout all editions, (including the 5th), it would appear that the original statement relating to the Nakum arches was made by Morley in 1946. With all due respect to the learning and archaeological expertise of Sylvanus Morley, as far as I have been able to ascertain, (and I stand to be corrected on this if I am wrong), Morley, unlike Tozzer, never excavated or mapped the site himself. The only mapping survey subsequent to Tozzer's 1913 publication seems to have been undertaken by Nicholas Hellmuth in 1973.

IT IS UNFORTUNATE that Tozzer's plan drawing of the facade of Temple A (**Figure 5A**) is lacking in the required detail and is not a section and elevation drawing. It is also difficult to determine the necessary detail from Tozzer's photograph (**Figure 5B**). As can be seen, although the curves of the two outer arches seem to be comprised of wedge-shaped blocks, it is not possible to be certain whether

the actual construction method employed was that of a true or corbeled arch. It has, so far, not proved possible for me to find any detailed photographs of the interiors of the vault that would settle the issue one way or the other. So, until I am able to examine the actual construction methods employed, or find someone who has, it is impossible for me to state categorically that the Nakum arches are "true". The reader must, for the time being, decide whether he wishes to believe Tozzer, the experienced observer who actually undertook a mapping survey of the site, or Morley, the experienced observer who didn't. Personally, I am inclined to believe Tozzer who, with regard to these arches, says that 'They are the first and only examples of the true arch that I have met with in Maya buildings'. (Bear in mind that Tozzer was writing before Ruppert & Denison's 1933 discovery). It is also noteworthy that Tozzer feels that the arches could not have been built without some form of temporary wooden support. Recall: A temporary supporting structure must be erected within the vaulted area during construction of a true arch or vault. A corbeled arch or vault never requires a temporary support during construction.

OF INTEREST is Ekholm's conjecture that it is possible that knowledge of the true arch could have been introduced and applied for a time in one region before it succumbed to the more established tradition of corbeled vaults. Nakum lies about 100 miles to the south of la Muñeca, so they are not too distant from one another. There may even be evidence of relationship between the two sites. The earliest Long Count Date recorded at La Muñeca is on Stela 5 upon which is inscribed the Long Count date of 9. 17.10. 0. 0. (Using the 583.284 correlation constant, this correlates to A.D. 780). The last Long Count Date recorded is on stele 1 where the date 10. 3. 0. 0. 0. is inscribed, correlating to A.D. 889. Therefore, it could be reasonably safe to assume that the true arch at La Muñeca was built sometime during the 8th and 9th centuries A.D. At Nakum the earliest Long Count Date recorded (stela U) is 9. 17. 0. 0. 0., correlating to A.D. 771, and the last Long Count Date recorded (stela D) is 10. 1. 0. 0. 0., correlating to A.D. 849. This is virtually the same period of fluorescence as for La Muñeca. So, at both La Muñeca and Nakum, sites lying in regional proximity, the true arch seems to have been introduced during the same 100 odd years.

IT IS DIFFICULT to ascertain whether the true arches (if that's what they are) at Nakum comprise the third example of the three true arches recognized from PreColumbian Mexico. So far, I have been unable to discover any mention of the Nakum arches by Ekholm. However, Ekholm does mention the possibility that (true) domes were constructed at the site of El Tajin in Veracruz.

Domed Vaults at El Tajin:

In his reply to Schwerin, Ekholm[19] called attention 'to the occurrence, not widely known, of an unusual roofing system at Tajin, briefly described by Marquina (1951: 439, 448).' Ekholm says that roofs of several smaller buildings at the site 'apparently consisted of a solid layer of lime mortar having a smoothed under-surface that was shallowly concave or arched.' In her communication, Dr. Kehoe said that Ekholm described these as "true domes". Also distinctive, according to Ekholm, is the mortar which 'contains abundant pieces of

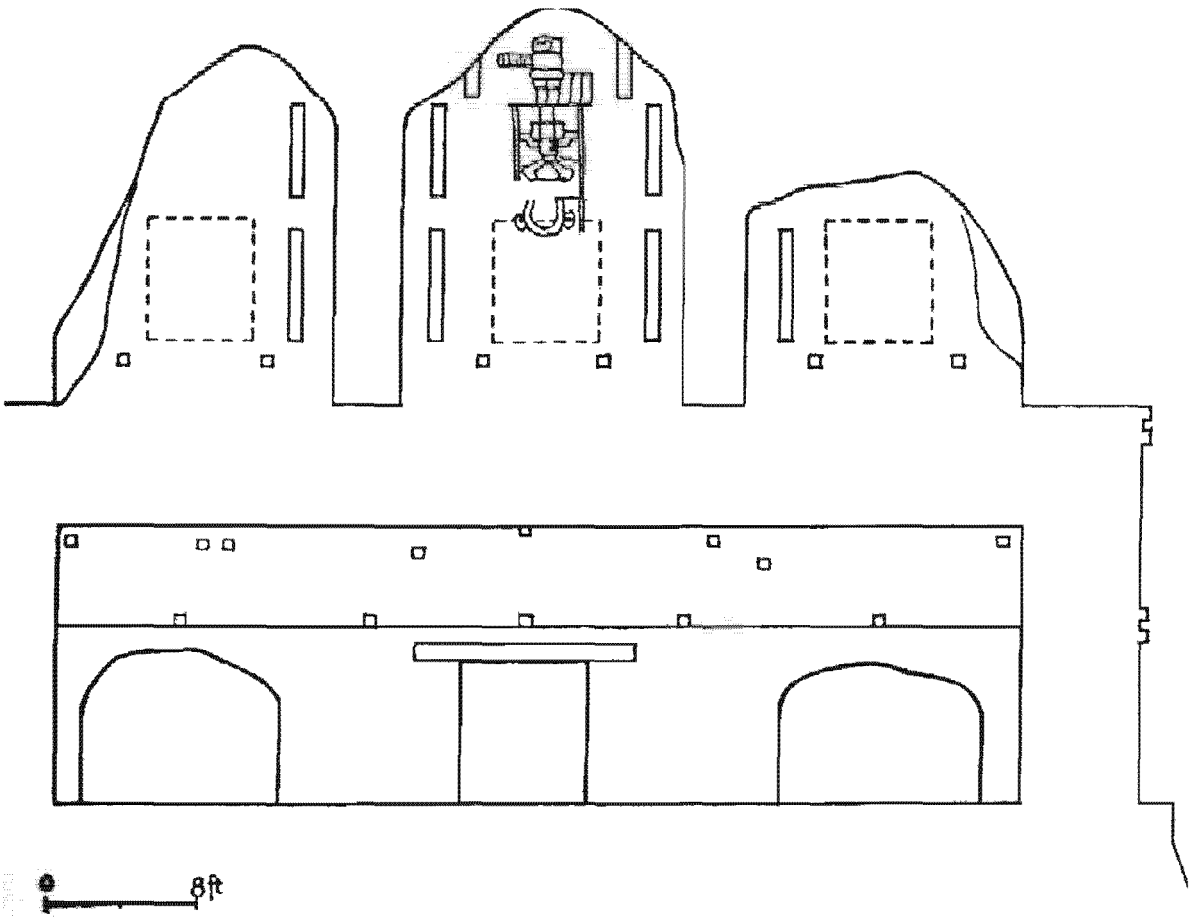

Figure 5A: Tozzer's plan drawing of the facade of Temple A at Nakum. The arches have A "rounded" appearance, (as does the Palenque arch in Figure 3A), but lack of detail for the actual structure of the inner core of the arches makes it difficult to determine whether they are true or corbeled. However, see text for discussion of this aspect.

Tracing by D. Eccott from Tozzer's original.

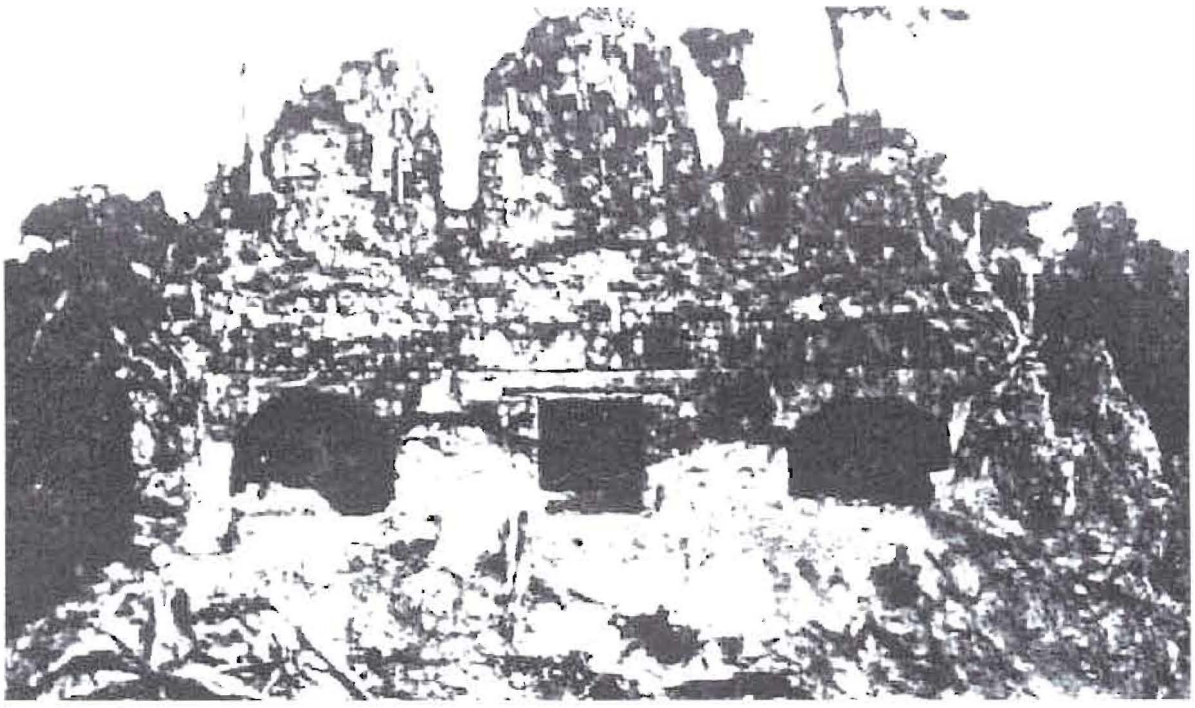

Figure 5B: Photograph of Temple A at Nakum showing the two arches either side of the central doorway.

light-weight pumice, potsherds, and sea shells, used apparently to bind the mortar and to decrease the weight of the mass.' Such an occurrence is virtually without precedent in the Maya region. The only other Maya site where such unusual structural techniques occur is at Comalcalco in Tabasco where some of the corbeled roofs contain broken pottery that was placed in the fill to lighten the load of the arch. Furthermore, possible alphabetic characters, as well as various designs and motifs, (possibly Indo/Asiatic in origin) that were inscribed on some of the fired clay bricks at the site, has led to speculation that Comalcalco was, in part at least, the result of an intrusion via the Pacific.[20] The implication being that Comalcalco may provide corroborative evidence of Old World structural techniques having been conveyed via transPacific contact.

EKHOLM points out that the domed roofs at El Tajin are no longer in position, and that the prime evidence for their existence are a number of large blocks of mortar, up to a meter or more in thickness. He also draws attention the fact that Marquina[21] suggested that such roofs would, of necessity, have been **constructed over temporary forms of some kind.** Therefore, it appears that yet again we have roofing appearing in the Maya world that required temporary support during construction.

Stephen Jett also draws attention to the fact

that, in Peru, domes were constructed in Chulpa tombs.[22]

Roys, Lawrence, and Shook also report on beehive domes at the Late Preclassic/Early Classic Maya site of Ake, Yucatan.[23]

Important Considerations:

Whilst some may still argue that the true arch at Oztuma is a post-Columbian structure, it seems that this is unlikely for the reasons given above. Although a question mark must remain, at least for the time being, as to whether the Nakum arches are "true" as reported by Tozzer, the evidence seems to suggest that they are. There can be no doubt, however, that the arch at the Sweat Bath at La Muñeca is an example of a true arch that existed in PreColumbian America. As such it belies the oft-repeated statement that the true arch was unknown in PreColumbian America, and that the high cultures of the continent did not possess the skill or knowledge to construct one. Therefore, from the point of view of absolute certainty, it can be said that only one example has survived. This being so, it would be foolish to assume that there were not others, even though they seem not to have survived.

This leads to the question of whether the technique for constructing the true arch was diffused from the Old World. Of course, whatever one may personally believe, it is impossible to say for certain. There are, however, a number of factors worth considering.

FIRSTLY, IN THE Old World, up until the Roman period, the true arch, although known and used in many cultures, was not fashionable. Its use was extremely limited. This seems to have been the case for the true arch in the Americas, thus offering a parallel.

Secondly, in the Old World, the true arch was used mainly in secular (i.e. worldly, non-spiritual, non-sacred) structures, or in structures that were not designed on a grand scale. The true arch at La Muñeca was incorporated into the relatively small structure of a sweat bath, thus suggesting the same criteria for the use of true arches in the New World. Here, it would appear, we have another parallel. (The exception would seem to be the possible true arch at Nakum, which had been incorporated into a monumental temple structure. If these are true arches, their use in a temple would represent a very strong deviation from the norm. Even the Romans generally retained the Greek tradition of post-and-lintel doorways in their temples; one of the few exceptions being the Pantheon in Rome).

THIRDLY, because of its limited use in the Old World, the architectural and aesthetic potential of the true arch and its structural strength was never exploited until the Roman period. The same holds true, it seems, for the true arch in PreColumbian America. Notice, for instance, that at La Muñeca the Maya did not make use of the wide span possible with a true arch. According to Ruppert & Denison's scale on their drawing, the span of the arch is only one-and-a-half meters (barely 5ft). As such, a third parallel exists. Might it not therefore have been the case, (and I speak guardedly), that the conditions under which true arch construction could be applied were diffused along with the technology for its construction? This is not to say that the Maya were not advanced enough to have

been capable of inventing the true arch themselves. Of course they were, and even if the knowledge was diffused from the Old World it does not mean that the Muñeca arch, for instance, was constructed by non-Mayas. From the evidence of other structures at the site that contain all the hallmarks of Maya construction, La Muñeca was undoubtedly built by the Mayas. Therefore, if true arch technology was diffused to them, they had obviously understood it and were fully capable of executing it. By the same token, it might well be pertinent to ask whether the true arches of the Egyptians, Greeks, and Etruscans were homegrown inventions, or whether the technology was merely borrowed from previous ages, having been diffused throughout the Old World.

Before leaving this topic, there is one more important factor to consider. Exactly why was the true arch not more widespread amongst the Egyptians, Greeks, Etruscans, Han Chinese, and the Maya, etc.? Why was it not fashionable, and why did none of them fully exploit the technique? As Ekholm points out, the principle of the true arch is not something that would necessarily become popular. But is there a more practical reason why many ancient civilizations, including the Maya, may have possibly felt uncomfortable with the true arch? In the aforementioned communication that I received from Dr Alice B. Kehoe, it is stated that Paul Shao, in one of his books on transPacific contact, makes the point that corbeled arches are stronger than true arches in earthquake zones.[24] The fact that the corbeled arch is more earthquake-resistant could well have been a strong contributing factor to it being preferred to the true arch in monumental construction where large numbers of people would gather. Was such a factor also conveyed to the Maya through transPacific contact?

DESPITE SUCH a rhetorical question, diffusion is really not the central issue in this discussion. Although the Muñeca arch means that the supposed absence of the true arch cannot be used as an argument that contact between the Old and New Worlds did not occur, it does not prove that it did. The important issue is, therefore, one related to the continued neglect of the fact that the true arch was known in PreColumbian America. Let us recall the words of Ekholm who in 1964, with regard to the Muñeca arch, wrote 'why is it that this seemingly good evidence for the ancient Maya having known the true arch was published over twenty years ago and since that time has been scarcely mentioned? Its significance has not been discussed and it has not been mentioned or considered in connection with any of the more general discussions of Maya culture or American civilizations.' As I write the concluding paragraphs of this essay, the date is now January 14th 2003. **It is now 60 years since this seemingly good evidence for the ancient Maya having known the true arch was published, and still it is scarcely mentioned.** Although the Muñeca arch has been spoken of in various essays of a diffusionist nature, its significance is still not considered in connection with any of the more general discussions of Maya culture or American civilizations, nor is it mentioned in professional journals related to the Maya. How much longer will it be neglected? For another 60 years, or even longer? Is it so insignificant? Is it so "unwanted"? Was the Ruppert and Denison 1943 report on the Muñeca arch simply just much ado about nothing?

Those of conventional doctrine who, in the words of McGlone, Leonard, and Barker,[25] 'desire to have a pristine "laboratory" for the basic study of cultural development without outside influence' in the Americas, and who wish to see 'the high cultures of the New World developing in a hermetically sealed

hemisphere', are sometimes all too ready to accuse those of the opposing viewpoint of being racist, and of not crediting the peoples of PreColumbian America with sufficient intelligence to have been able to establish their own cultural and intellectual momentum without contact from across the oceans. And yet, in this instance, they continually deny the Maya their right with respect to having had the knowledge and skill to have constructed a true arch. After 60 years, one wonders what state of disrepair the true arch at La Muñeca is now in. Should it ever be allowed to tumble away completely out of site and out of mind, it is hoped that this essay will, if nothing else, help to preserve its memory.

Conclusion:

The true arch **was known** in PreColumbian America.

Addendum:

AFTER COMPLETING the text for this article, I came across a recent photograph of Temple A at Nakum. As can be seen from the photograph **(Figure 6)** the two lateral arches have now been totally blocked off by, what appear to be, large, made-to-measure, blocks of stone. (If one didn't know better, one could be forgiven for assuming that these chunks of stone are an original and integeral part of the structure). Although it is difficult to discern detail, the blocks that once comprised the curve of the arch (visible in Tozzer's photograph) now seem to have been either removed or plastered over. The central doorway also seems to have been blocked so that access to the temple is impossible. Of course, there may be many reasons for this, and it may be nothing more sinister than an attempt to solidify the structure and to prevent damage to the vaults by disallowing any access. However, it does seem a rather extreme method of "reconstruction", especially considering that there are other, less drastic and equally efficient methods of solidifying and protecting a structure a structure without severely altering it's original design concepts. Whatever the reasons, the result is that the vaults, which may, as we have seen, be fine examples of true vaults that were constructed in PreColumbian America, are now totally "out of sight and out of mind". I intend to make enquiries, but any information would be greatly appreciated.

NOTE.
Throughout this text I have used the spelling "corbeled" except when "corbelled" has been used in an original quote.

Figure 6: Recent photo of Temple A at Nakum.
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