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RESEARCH ARTICLE

FROM NULL SIZE TO NUMERICAL DIGIT; THE BEHEADED QUEEN BEE AS A MODEL FOR THE MAYAN ZERO GLYPH T173, EXPLAINED THROUGH BEEKEEPING

Da dimensão nula ao dígito: a abelha rainha decapitada como modelo para o glifo maia zero T173, explicado através de criacão de abelhas

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ABSTRACT

The characteristic signs for natural numbers and zero that pre-Hispanic Maya scribes used to depict counting facts must have been developed based on daily life experience, although for several of them their origins remain unclear. One such case is the sculptured, three-sided or partially visible quatrefoil glyph, catalogued as affix T173. This glyph had several textual functions, but its scribal variations were most frequently used as a positional zero. In several cases of T173's use, its syllabic reading has been recognized as *mi*, which can be translated into "lacking". Yucatec Mayas kept stingless, meliponine bees for honey and wax production and trade, and the cultural value of this practice reveals itself through the worshipping of several bee and beekeeping gods. In species of the genus *Melipona*, queens are constantly produced. Worker bees eliminate superfluous and useless queens all year round, commonly by biting off their heads. These worker-controlled killings of excess queens allow colonies to perpetuate themselves but occasionally lead to irreversible colony loss, which would seriously undermine honey harvests. Beheaded queen bee figures in the Madrid Codex demonstrate that Mayan beekeepers knew from experience how the deaths of residing queen bees affected their beekeeping businesses. Here I propose that Maya artists sculpted beheaded queen bees and used them, among other things, as zero placeholders in counting, namely T173. If this rationale is correct, the presence of this glyph on Classic period monuments reinforces the idea that Maya beekeeping has a long-standing tradition and was more widespread than is generally acknowledged. In its zero position, glyph T173 may originally have embodied a pre-existing concept of "nothing" or "void" from beekeeping: a vacant beehive due to the permanent loss of the queen caste. Additionally, the effect of other aspects of adult lifecycles of *Melipona* queens on colony development could explain other textual applications of glyph T173.

KEYWORDS: Classic Maya civilization, T173, stingless beekeeping, *Melipona beecheii*, queen bee decapitation, vacant hive.

RESUMO

Os característicos símbolos de números naturais e zero que os escribas maias pré-hispânicos usaram para revelar fatos de contagem devem ter sido desenvolvidos baseados em experiência da vida cotidiana. Entretanto, para vários deles seus origens continuam desconhecidas. Um destes casos é a figura de três-lados ou quadrifólio parcialmente visível, catalogado como afixo T173. Este glifo tinha diferentes funções textuais, mas suas variações escrivais eram mais frequentemente usadas como zero posicional. Em vários casos de uso de T173, sua leitura foi reconhecida como *mi*, que pode ser traduzido em "ausente". Maias yucatecos cultivaram abelhas sem ferrão para a produção e comercialização de mel e cera. O valor cultural desta prática se manifesta através da adoração de vários deuses relacionados às abelhas e ao seu manejo. Nas espécies do gênero *Melipona*, abelhas operárias eliminam rainhas supérfluas e inúteis o ano todo, comumente decapitando-as. Esta matança controlada de rainhas pelas operárias permite às colônias se perpetuar, mas ocasionalmente causa a perda irreversível da colônia e assim poderia colocar em perigo a colheita do mel. Figuras de rainhas decapitadas no Códice de Madrid mostram que criadores de abelhas maias sabiam, pela experiência, como mortes de rainhas poderiam afetar os seus negócios. Aqui proponho que os artistas maias usaram o desenho de uma abelha rainha decapitada, entre outras coisas, como um zero de posição esculpido, sendo T173. Desta forma, sua presença em vários monumentos do período clássico reforça a ideia de que a criação de abelhas pelos maias era uma tradição de longa data e era difundida mais do que se supõe. Uma colmeia vazia, causada pela perda permanente da casta da rainha, poderia ter sido o motivo da utilização do glifo T173, na sua posição zero, para simbolizar o pré-existente conceito de "nada" ou "vago". Além do mais, o efeito de outros aspetos dos ciclos de vida adulta das rainhas *Melipona* no desenvolvimento colonial pode explicar outros usos textuais de T173.

PALAVRAS-CHAVE: Civilização Maia Clássica, T173, criação de abelhas sem ferrão, *Melipona beecheii*, abelha rainha decapitada, colméia vazia.

Zero symbols in Classic Maya civilization, and stingless beekeeping

For many centuries human cultures have marked quantities with symbols and figures (see KAPLAN, 2000). The use of zero in counting systems is of more recent date, and it started off as a placeholder. The concept of zero as a number only began with the Indians around the ninth century AD (see IFRAH, 1985), although Mayas from the pre-Hispanic period also may already have been aware of the notion of null size early in their history (see BLUME, 2011).

The pre-Hispanic Mayas operated a counting system that was vigesimal-based and used bars and dots to depict integer units and day numbers, and their respective orders of magnitude (BRINTON, 1894; MORLEY, 1915). Several different figures functioned as zero placeholders (BRINTON, 1894; see BLUME, 2011). Among those figures, some appear shell-like; others look like three-sided or partially visible quatrefoil structures (Figure 1). The latter glyph forms were catalogued as affix T173 (THOMPSON, 1962) and also functioned to express “completion”, phonetically complemented “death” (Figure 1F), or were part of the so-called “half period glyph” (Figure 1G) (MORLEY, 1915). In several of its uses, it has been suggested that T173’s syllabic reading is *mi* (GRUBE and NAHM, 1990), which can be translated as “lacking” (KAUFMAN, 2003). According to GRUBE and NAHM (1990), glyph T163 (Figure 1H) is similar in layout to, and also has the same syllabic reading as glyph T173.

KARADIMAS (2008) identified a solitary wasp and its reproductive behavior as a possible, common element of mythological figures known as Yurupari. These figures make part of the mythical domain of some ethnic groups from the North-West Amazon like the Miraña and certain Tukano speaking groups. As with other Mayan counting signs, the iconic interpretation of the T173 zero glyph remains unsolved (BLUME, 2011). Here I try to unravel part of this mystery by showing that the origin of T173 glyphs’ design may lie in the Mayas’ experience with keeping of stingless honey bees and their understanding of specific reproductive traits of these insects that live in perennial, single-queen societies.

At the time of the Spanish conquest, Yucatec Mayas produced, used and traded bee honey and wax produced by stingless bees (SCHWARZ, 1948); they hived their bee colonies in horizontally oriented, hollowed-out logs or *hobones* (CRANE and GRAHAM, 1985). The Madrid Codex is one of a few screen fold manuscripts dating from the so-called Postclassic period (ca. AD 900-1520s); it includes iconographic information about pre-Hispanic Maya culture and religion (see Vail, 2000). Part of this Codex provides a pictorial account and calendar of beekeeping practices (VAIL, 1994; CAPPAS E SOUSA, 1995, 1996). Mayan bee husbandry also formed part of religious life because bees were considered to be sacred (JONG, 1999). Among their numerous gods they worshipped a bee-representing god, *Ah Mucen-kab*, and a bee shelter and bee hive-protecting god, *Hobnil* (MARTÍNEZ, 1938; WEAVER and WEAVER, 1981). Mayas used honey both for food and medicinal purposes and still use it to prepare a fermented, sacred drink named *balche* (LANDA, 1937; WEAVER and WEAVER, 1981). In its traditional form, honey harvesting was usually accompanied by ritual acts; every couple of years a major bee blessing ceremony with offerings was held by a local priest. Even today, traditional Yucatec beekeepers treat their bees with care and respect. They clean honey-soaked bees during hive manipulation, and bury dead individuals (WEAVER and WEAVER, 1981).

Spanish post-conquest reports and excavated clusters of circular hive plugs or *panuchos* hint at previously large concentrations of beehives at single locations (OVIEDO y VALDÉS, 1851-1853; CRANE and GRAHAM, 1985). To protect them from direct sun and rain, hives were placed in simple freestanding structures with a roof. Individual bee shelters could hold up to several hundreds of hives, which were closely stacked together (SCHWARTZ, 1948). Currently, a few remnants of traditional beekeeping can still be found scattered throughout the Yucatan Peninsula (VILLANUEVA et al. 2005). The main bee involved is *Xunan-kab*, the stingless bee species *Melipona beecheii* Bennett (Insecta, Hymenoptera, Meliponini) (SCHWARZ, 1948), which is distributed from Mexico to Costa Rica (WILLE, 1976). Although specimens have been collected from mountainous areas at altitudes of more than 1000 meters, *M. beecheii* mainly inhabits dry lowland areas (AYALA, 1999). Individual nests, similar to those of other species of the genus *Melipona*, can persist for several decades (JONG and SOMMEIJER, 2004; COHN, 2005; SLAA, 2006). Such longevity would have easily spanned two or more Mayan generations (HUBER, 1839), which implies a steady and long-term source of wealth for families and communities that owned these bees (JONG, 1999).

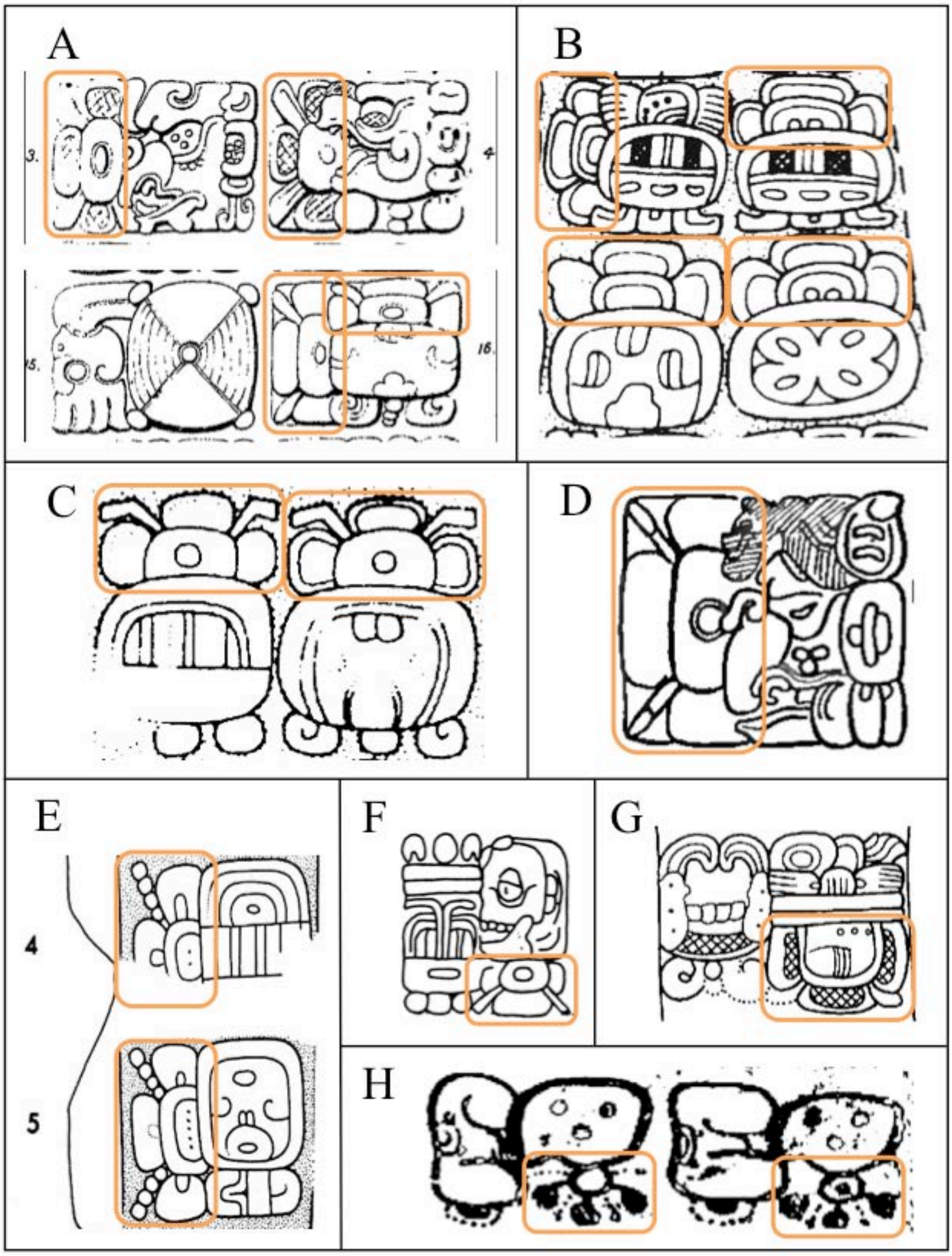

Figure 1: Scribal variations of T173 glyphs found on Classic period monuments, and T163. A) Quiriguá Stela C, west side (MAUDSLAY, 1899-1902); B) Tikal Stela 31 (STUART, 2011); C) Pusilha Stela E, back side (PRAGER, 2013); D) Quiriguá Stela E, east side (MORLEY, 1915); E) Tonina Monument 101 (GRAHAM and MATHEWS, 1996); F) Dumbarton Oaks, Relief Panel 1, J1 (after COE and BENSON, 1966); G) Stela A, south side (Schele Drawing Collection); H) T163 glyphs on page 20, Dresden Codex (T173/163 glyphs are in orange sectors).

Reproduction in single-queen, perennial *Melipona* colonies

The biology of stingless bees and their management, also called meliponiculture, differs significantly from that of the better-known *Apis* honeybees (Insecta, Hymenoptera, Apidae) (MICHENER, 1974). These social bees are limited to the tropical and subtropical regions of the globe and their sting is atrophied; consequently, they use their strong mandibles as their main weapon of defense. Handling these bees is uncomplicated and safe, which enables the installation of hives nearby settlements. In general, stingless bee colonies are less populous and have fewer food reserves than *Apis* colonies but more colonies can be maintained at each location and their honey is highly valued (CORTOPASSI-LAURINO et al., 2006). Just like *Apis* honeybees, stingless bee colonies are generally headed by a single queen (monogynous), which is the sole reproducing and mated female (MICHENER, 1974). The queen is larger (Figure 2) and lives significantly longer than the worker bees and is, when it is no longer productive, killed by worker bees and replaced by one of its virgin daughter queens in order to guarantee colony survival. While the queen produces the offspring, the workers build and protect the nest and collect food. Worker bees are directly responsible for the production of honey and wax.

In stingless bees, workers seal off brood cells right after they have mass-provisioned them with a liquid mixture of pollen and honey and the queen has laid its egg on top of this liquid (SAKAGAMI, 1982). Given that these cells are only opened when the bees are fully developed, both sex and caste are determined at egg laying.

Stingless bee colonies persist by the virtue of natural transitions between subsequent, egg-laying queens (SAKAGAMI, 1982). Individual queens have a lifespan of one to two years; some days after a residing queen dies, workers accept a new young queen to continue brood production (SILVA et al. 1972). Therefore, to assure that queen substitution processes in the genus *Melipona* are successful at any moment in time, colonies in this taxon rear excess virgin queens all year-round (IMPERATRIZ-FONSECA and ZUCCHI, 1995; KOEDAM et al. 1995).

Figure 2: Adult, egg-laying queen surrounded by a court of its daughter worker bees as an example of morphological caste differentiation in the stingless bee genus *Melipona*. This picture emphasizes the large rear part or abdomen of a productive queen (*M. fasciculata* Smith, 1854), which contains her ovaries and egg-laying apparatus.

In natural populations of highly social or eusocial insects like honeybees, colonies as a whole propagate by swarming or budding (MICHENER, 1974). In stingless bees, the procedure can be summarized as follows: a significant part of a nest's worker population splits off and, together with a young, virgin queen, establishes itself in another, neighboring location, while the remainder stays behind with the old queen and continues its growth and development.

Occasionally, stingless bee colonies succumb and various factors are to blame. Predators such as ants and parasites such as scuttle flies (Phoridae) may invade the nest, consume the honey and pollen and even attack the brood and adults (ROUBIK, 1989). Another significant risk for colony failure is the case in which, after the death of the residing queen bee, a new young queen does not take over the egg-laying role. The morphological, physiological and behavioral caste differentiation in the eusocial bees makes a queen and its worker bees mutually dependent (WILSON, 1971). Consequently, even in the presence of up to several hundreds of orphaned worker bees, colonies without a functional queen are doomed to perish. It is in such situations that the end of the life of the sole individual that produces the eggs may lead to the extinction of the entire colony.

Natural queen death by typical worker-provoked beheading

Melipona worker bees eliminate surplus of virgin queen bees within days after emergence (KOEDAM et al. 1995), and a common behavioral method of the worker bees' natural killing repertoire is decapitation of the victim (Figure 5A1, B1). In *M. beecheii*, the bee species kept by the Mayas, this conduct in which a worker positions its mandibles around a queen's neck and snaps off its head has been documented to occur in a quarter of all worker-executed killings (WENSELEERS et al., 2004). There is no reason to believe that killing by beheading will be much different for the cases in which worker bees get rid of old resident queens when they need to be replaced (SILVA et al. 1972). Soon after a queen is slaughtered, hive bees gather its remnants and, as they do with other colony waste, remove them from the nest (SCHWARZ, 1948).

The significance of queen bees for the production of honey and wax

In colonies with low brood production, the probability that a natural queen substitution event will fail and a colony dies off is increased. This vulnerability in the *Melipona* system of ensuring colony maintenance means that beekeepers, among other things, should always be alert to make sure colonies produce sufficient brood in order to guarantee that the sequence of egg-laying queens continues uninterrupted and thereby assure continued honey and wax production. Mayan beekeepers are likely to have recognized the value of a vigorous, egg-laying queen for colony survival and maintenance based on daily observations. They especially should have been aware of the direct and tangible, detrimental effects on their beekeeping practice in case the loss of a queen converts the momentary absence of the queen caste permanent. This may have been the initial reason for Mayan scribes to draw decapitated queen bee figures found on the pages 103 and 108 of the Madrid Codex (Figure 3) (CAPPAS e SOUSA, 1995). Each of these anterodorsal views (TOZZER and ALLEN, 1910) portrays three major body elements: a central part (thorax) missing the head, two lateral wings and the rear part or abdomen of the insect. Smaller parts, including a pair of antennae and other head parts such as the tongue (glossa) and "teeth" (mandibles), as well as legs variably decorate these illustrations.

From a beheaded queen bee to the sculptured glyph T173

Here I propose that during the Classic period (AD 250-900) Maya artists sculpted beheaded queen bees and used them, among other things, as zero placeholders in counting, thus inventing the three-sided or partially visible quatrefoil glyph, also known as T173 (Figure 1). To this end, the scribes depicted beheaded queen bees in anterodorsal positions comparable to those painted in the Madrid Codex (Figure 3). However, this bilateral symmetric glyph design became more stylized, so

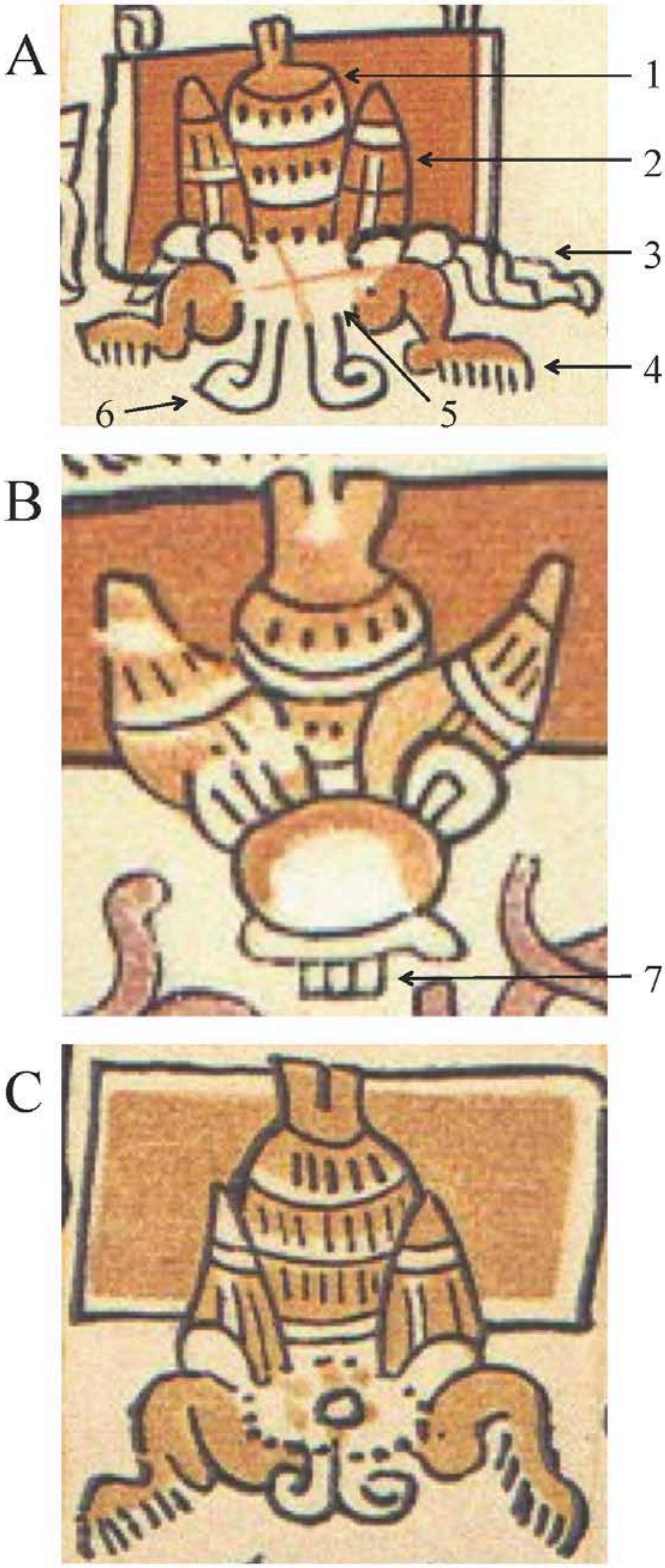

Figure 3: Headless queen bee figures depicted in anterodorsal positions, from the Madrid Codex, as examples of the possible significance of this bee individual when dead for Mayan beekeeping A) (p. 103b), B) (p. 103c) and C) (p. 108a). (1) Abdomen, (2) Left wing, (3) Left antenna, (4) Left leg, (5) Place where head was severed from the thorax, (6) Tongue (glossa), (7) "Teeth" (mandibles).

that it was composed of at least three and up to no more than four different body parts (Figure 5A2, B2, C). Its center is marked by a circular space, often with an open dot, which probably stands for the thoracic body part and its microthorax (SNODGRASS, 1910), from which the head is severed. The three lobes that are attached to this inner circle probably represent a pair of wings and the abdomen. In some glyph variants, rod-like structures are situated in between these lobes; these can be interpreted as a pair of antennae (Figure 1A, C-G). In real life, these antennae are a set of tiny, rod-shaped structures protruding from the front side of the head. No observant Mayan stingless beekeeper would have been unacquainted with the physical presence of these head structures on the guard bees that incessantly protect their nest entrances (Figure 4). This experience may explain why Mayan scribes considered bee antennae important enough to occasionally display them in T173 glyphs.

The depiction of different mouthparts and antennae of the beheaded queen bee figures (Figure 1, 3) reveals a sound knowledge of Mayan scribes about the morphological details of small objects. For instance, although they visibly stand out, a bee's antenna has a diameter of only about 0.15 millimeters. In some T173 glyphs, scribes depicted each antenna as two connected stalks (Figure 1C, D), which is in accordance with this head appendage's bi-partitioned nature (SNODGRASS, 1910): a basal up and outward directed part, the so-called scape, and a downward hanging part, the so-called flagellum. In other cases, scribes even portrayed the individual joints of the second part of the antennae (Figure 1E). In spite of the Maya scribes' expertise and trained eye, the representation of mouthparts and antennae in images of beheaded queen bees is actually incorrect; when a bee is decapitated, these parts are lost together with the head, either because they make up the lower part of the head or because they are fixed near to the center of the bee's face, in between the compound eyes, respectively (SNODGRASS, 1910). The underlying motives for scribes to have portrayed such morphological inaccuracies could be various, but to discuss them at this point would go beyond the scope of this study.

Figure 4: View of the antennae of a stingless *Melipona* worker bee guarding the hive entrance, showing how these tiny but characteristic structures could not have gone unnoticed by Mayan beekeepers.

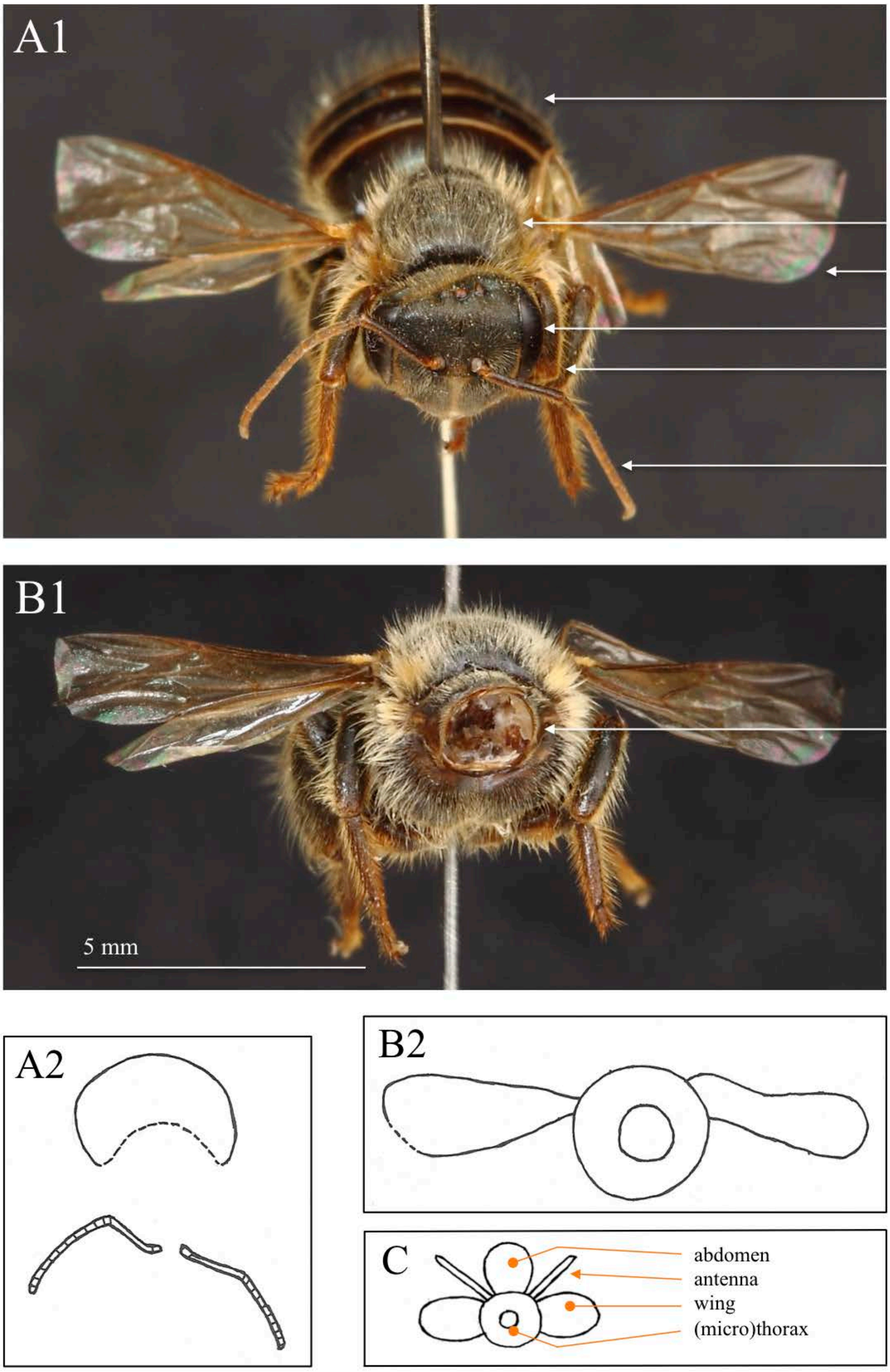

Figure 5: Sequence of photos and illustrations showing the queen bee body elements suggested to constitute T173 glyphs. A1) *Melipona* stingless queen bee (virgin queen of *M. fasciculata* Smith, 1854), anterodorsal view before and B1) frontal view, after decapitation (done by the author but with an outcome similar to what killing worker bees would cause) of the same individual as in A), (1) Abdomen, (2) Thorax, (3) Left wing pair, (4) Head with two large lateral, compound eyes, (5) Left front leg, (6) Left antenna (composed of a 1-segmented scape and a 11-jointed flagellum) and (7) Place where head was severed from the thorax (microthorax); A2) and B2) graphic highlight of the queen's body parts, these being abdomen and antennae, and wings and thorax, copied from A1) and B1), respectively. These are hypothesized to have served as model compounds for glyph T173; C) Scheme of a T173 prototype composed of the four elements depicted in A2) and B2) respectively. Note that each of the pairwise antennae and wings is mirror-imaged over the thorax-abdomen symmetry line.

T173, Mayan beekeeping history, and T163

One might think that beekeeping of any relevance emerged only relatively late in Maya civilization history. After all, the bee almanacs of the Madrid Codex seem to represent a calendar based on pre-Hispanic beekeeping and its ceremonies (VAIL, 1994), and this document was probably written during the Postclassic period (ca. AD 900-1520s; see VAIL, 2000). In addition, New World stingless beekeeping may have originated from the Maya of the Yucatan Peninsula (KENT, 1984). However, if the creation of the T173 inscription is really based on a model of a beheaded queen bee as put forward in this paper, then its development and use would not only emphasize the important role of stingless bees and their keeping in Classic Maya civilization, its occurrence would also help put the history and geography of this agricultural activity into perspective. For instance, T173 glyphs occur on stone monuments that date from AD 357 up to AD 909 (see BLUME, 2011). Several of these monuments were found at sites outside the Yucatan Peninsula, including Copán (Copán, Honduras), Piedras Negras (Petén, Guatamala) and Toniná (Chiapas, Mexico). The age and location of some of the monuments having T173 glyphs therefore suggest that the Mayas also practiced bee husbandry beyond the Yucatan Peninsula since at least the Early Classic period. An overview by CRANE and GRAHAM (1985) of the periods and locations of sites of the excavated stone discs or *panuchos* supports this view.

Glyph T163 (Figure 1H) has a syllabic reading and overall shape comparable to glyph T173 (GRUBE and NAHM, 1990). However, its layout is somewhat less elaborate than that of T173 and its timeframe was the Postclassic period if the supposed manufacturing period of the Codices in which it appears is set as a point of reference (VAIL, 2000). Since T173 glyphs have been encountered on stone monuments dating from the Classic period (see BLUME, 2011), it is possible that T163 is a kind of updated version of T173.

The relatively abstract glyph T163 and the more realistic figures of headless queen bees (Figure 3) both are found in the Madrid Codex. So, scribes used these two very different looking groups of images independently of each other in the same manuscript, but they were likely unaware of the possibility that both derive from the same natural phenomenon of stingless bee biology, namely queen bees killed through beheading by worker bees. Even though the physical state of such victimized bees certainly may have appealed to the Mayas' imagination, the recurrent creation and employment of these bee models in texts in particular demonstrates that the incidences of queen bee deaths themselves comprised valuable information for the people who kept these bees.

A possible "null size" origin for zero glyph T173

In several of its textual functions, the syllabic reading of glyph T173 has been deciphered as *mi* (GRUBE and NAHM, 1990), which can be translated as "lacking" (KAUFMAN, 2003). THOMPSON (1950) had glyph T173 particularly in mind when he wrote (page 137-138): "*I am sure, although there is no evidence pro or con, that the Maya would not have used this sign in the sense of nil had they, for example, been required to report on the production of some crop that had been a total failure*". If one presumes that a beheaded *Melipona* queen bee served as model for this glyph, it is plausible that its most common use as a positional zero derived from a pre-existing concept of "nothing" or "void", namely an empty, colony-extinct beehive due to the irreversible loss of its queen caste. In that case, losing the possibility to harvest precious honey and wax because of this setback would offer a valid argument emanating from agricultural activity that THOMPSON was intuitively looking for when he wrote the line cited above.

Several other textual functions for T173 glyphs have been proposed (see GRUBE and NAHM, 1990). In principal, these functions could have been derived from other kinds of experiences or facts from the Mayas' daily routine. However, it makes sense to examine the underlying reasons for these other applications within the context of Mayan beekeeping tradition. For instance, the phonetic role of T173 in expressions of death (Figure 1F) could simply have stemmed from the death of an individual organism, in this specific case the worker-killed queen bee. Other functions, such as conveying "completion" or as a component in the so-called "half period glyph" (Figure 1G) (MORLEY, 1915) could be linked to the occurrence of natural deaths of *Melipona* queens as well. To better comprehend alternative ways in which other aspects of queen deaths could influence stingless beekeeping, additional biological information about the adult lifecycles of queens and their relationships with colony maintenance and reproduction is given.

Beekeeping-based interpretations of other T173 applications

Hunting for feral bee nests is a common, alternative way to obtain honey; but often the nests raided in this way suffer so much damage that it kills them (but see POSEY, 1983). The practice of beekeeping instead aims at exploiting nests during consecutive years. When beekeepers are experienced, they have two distinct options to improve honey and wax production. One is by rescuing colonies in peril and maintaining the normal ones in good condition for the upcoming honey harvest. In stingless bees, this task requires the monitoring of colonies on a nearly daily basis throughout the year, because stingless bees are relatively vulnerable (ROUBIK, 1989). As mentioned earlier, keeping brood production stable to guarantee successful queen substitutions is one of a beekeeper's greatest concerns. Therefore, for colonies, the process in which old, residing queens are regularly replaced by new ones is their lifeline to survival. On the other hand, and somewhat paradoxically, for aged, discarded queens, it is the same process that ends their individual reigning periods and this fact could well represent the cases in which T173's meaning is "completion".

The other possibility for beekeepers to augment honey production is to increase the number of hives by artificially multiplying existing colonies. In apicultural terminology such a multiplication technique is generally termed "making increase" or "colony splitting". From images in the Madrid Codex it seems that Mayan beekeepers not only hunted for natural bee nests and their honey contents in the field but were also capable of artificially multiplying colonies to augment their stock of hives (CAPPAS e SOUSA, 1995). This technique is still performed by present-day traditional Mayan beekeepers (WEAVER and WEAVER, 1981; see GONZÁLEZ-ACERETO, 2008). Like the honey harvest, the process of artificial colony multiplication is a seasonal activity only performed when general circumstances are favorable. Otherwise, both the original colony and its split will experience below average survival rates.

As mentioned earlier, a natural life history strategy in stingless bees is that colonies reproduce themselves by splitting into two subunits. This results in two independent colonies, each with its own queen. In a forced but controlled way, beekeepers exploit this natural reproductive trait. They manually split a single parent colony into two parts, but do not let the newly formed daughter colony escape. Instead, they start the new nest with the installation of some old combs and some worker bees, taken from the parent colony, in an empty hive. Afterwards, they maintain the daughter colony inside the bee shelter and place it where the original hive was located. This swapping act will help to furnish the starting colony with protection and food from flying bees. The parent colony that remains with the old functional queen and young brood is put in a new position inside or nearby the bee shelter. Importantly, beekeepers do not kill the old queen but set it aside in favor of a new queen. Workers of the newly installed colony instead will soon accept and raise one of the emerging queens as their new head. In sum, the commonly applied stingless beekeeping technique of colony multiplication envisions the doubling of future honey and wax production by artificially splitting a colony into two more or less equal halves, meanwhile securing the old queen in one of these subunits. As an outcome of this human interference, the old queen bee is kept alive to head just half the size of the original colony. It is this partial disposal following a colony-splitting event that T173's function in the "half period glyph" originally may have characterized. THOMPSON (1962) classified this variant as T173, but GRUBER and NAHM (1990) do not regard it as an allograph. There is a possibility that what this glyph variant is considered to initially have conveyed is a queen bee combined with a false impression of its death; in this way the opposing points of view put forward by these authors can be reconciled.

CONCLUSIONS

My account of the different aspects of the adult lifecycles of queen bees and their effect on the development of the colonies they head shows that the close resemblance between T173's general layout and the anterodorsal view of a beheaded stingless queen bee is probably not a stand-alone issue. As a matter of fact, the consequences described each offer a different argument that can clarify what the various textual uses of the T173 glyphs in Maya writing could have been based on. With the syllabic reading *mi* in mind, the role of T173 as a positional zero would thus far be the most cogent case because it originally may have denoted the breakdown of the queen caste, which eventually results in colony collapse and as a consequence puts a beekeeper's honey and wax harvest at risk. If the adoption of T173 glyphs by Mayas was truly based on their perception of a correspondence between a queen bee's specific physical post-mortem configuration and the state and development of its colony, then this would demonstrate how important beekeeping was in Classic Maya civilization. The potential impact of Mayan beekeeping practices, along with some notion of the biology of their bees, on their writing thus deserves more attention.

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