Imagining a Complex Maya Political Economy: Counting Tokens and Currencies in Image, Text and the Archaeological Record

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Exploring the long-term use of accounting practices and currencies by literate and numerate authorities contributes new information regarding the complexity of the political economy of ancient Maya society. Two forms of indirect, yet compelling, lines of evidence for accounting practices and currencies are presented in this article. First, we identify potential accounting devices (counting sticks and tokens) found in the tombs of royal scribes and nobles, based on the contextual associations and depicted uses of similar objects in Maya art such as polychrome vases and murals. Second, we argue that the long-term use and significant standardization of specific shell objects suggests their role as all-purpose monies, in addition to their complementary status as counting devices or numerical symbols. This paper addresses the intricate relationships between symbolism, value and multiple modes of exchange that have long been of interest to cross-cultural studies in anthropology.

The complexity of Classic Period lowland Maya economic institutions has been particularly controversial due to the scarcity of explicit records in hieroglyphs or in art regarding market exchanges, although evidence for tribute payments is clearer (e.g. McAnany 2010, 263; 2013). Maya art was produced or commissioned by nobles or royals and, accordingly, the subject matter reflects only selected aspects of state finance that may purposefully exclude aspects of commerce (McAnany 2010, 269–304). Recently, new arguments have been advanced for the importance of Classic-era Maya currencies, marketplaces and merchants (Dahlin *et al.* 2007; 2010; Freidel & Reilly 2010; Hutson *et al.* 2010; King 2015; Masson & Freidel 2012; 2013; Masson & Peraza 2014; McAnany 2010; 2013; Shaw 2012; Stuart 2006; Tokovinine & Beliav 2013). A fundamental aspect of both tribute and market exchange for the Maya area would have been a system of accounts, involving the use of general-purpose monies as well as tokens representing large quantities of items. The monetary dimension of Maya economies is hardly controversial for the Postclassic (AD 1100–1511) and Contact Periods (AD 1511–1542) due to ample historical documentation by Spanish chroniclers. These later periods were marked by a vast regional market exchange system that connected the Maya area from the Gulf Coast to the Caribbean and from the northern peninsula into the southern volcanic highlands, and beyond into the Central Mexican Aztec realm and Honduras (Masson & Peraza 2014; Sabloff & Rathje 1975).

Historical analogy provides a baseline from which questions can be asked of data pertaining to the earlier Classic Period (AD 250–900). What evidence exists for accounting practices of Maya scribes or other noble officials who kept track of courtly tribute or commerce? Do monetary units in use in the thriving Contact Period marketplaces have considerable time depth? Indicators are found in the art of Maya polychrome vessels, in the tomb assemblages of nobles and in monetary artefacts. In this paper, we first pursue several lines of indirect evidence in order to reconstruct the material record of accounting practices, which are also supported by direct historical analogy. Following this investigation, we consider the monetary tokens that we posit functioned in concert with such accounting practices and instruments. Both Maya accounting practices and

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currency tokens were conceptually linked to divination practices, calendric calculations and prophecy. Maya politics, and no doubt royal policies effecting the transaction of goods and services, were bound to these ritual and religious practices, and so the entanglement is understandable. However, in our view these ritual practices and their iconographic and artefactual expressions have long masked the pragmatic economic activities of scribes and other functionaries of Maya government. Our essay builds generally on the arguments of David Graeber, an economic anthropologist who, in his recent book *Debt, the First 5,000 Years* (2012), argues cogently that currencies or monies are tokens of debt and, essentially, abstract devices that measure debt the way that calendar mathematics measure time, for purposes of facilitating the administration of the exchange of goods and services. This economic model makes good sense of the Precolumbian Maya practices, as we perceive them.

The existence of scribal accountants and currencies in long term use is relevant to both tribute and market exchange systems. Scribes, sages and calendrical specialists had the skills essential to tabulating large numbers involved in all types of calculations, including transfers of goods. The tools of these activities, we argue, would have included styluses, writing tablets, counting 'sticks and stones' often made of fine materials like bone and shell that, as we will illustrate, served as tokens representative of key commodities, and currency items. Certain shell beads and related suspended shell ornaments represent one important non-perishable currency category of middling value in use at Contact and probably long beforehand (Freidel *et al.* 2002). The status of shell monies and other currency units as general-purpose monies is reflected by the fact that all types of goods or services could be purchased with them at the time of European Contact. A better understanding is needed of the relationships between tokens representing goods (sometimes in large quantities) and actual currency units, and this paper focuses on the best candidates for tokens, monies and related tools of the trade.

The role of currencies has perplexed scholars studying parts of the pre-modern world well beyond the Maya area (e.g. Cribb 2005; Maurer 2006; von Reden 2010). More primitive views of the economic institutions of non-western states dominated the fields of anthropology and history for many years, but are now under critical reconsideration (e.g. Feinman & Garraty 2010; Smith 2004; von Reden 2010, 8–11, 89). Reviewing Paul Bohannan's (1959) seminal research, Graeber notes that currencies of state societies have too often been categorized as special-purpose monies of the sort that are commonly used among non-state societies. Special-purpose monies, or what Graeber (2012, 130) has relabelled 'social currencies', are used to symbolize social debts in a 'human economy', many of which cannot actually be repaid. In Maya studies, Dorie Reents-Budet (1994, 74) identified the finely painted polychrome ceramics of the Classic period as such social currency. As Graeber points out, social currencies are not used to purchase goods. Reents-Budet and her colleagues explore the use of Maya painted ceramics in funerals, court feasts, weddings, where they functioned in the human economy: 'the creation, destruction and rearranging of human beings' as Graeber (2012, 130) would have it. In contrast, general-purpose monies meet some of the criteria essential to their definition as presented by Bohannan: a means of exchange, a method of payment, a standard of value, a store of wealth, or a unit of account. These monies are used to purchase all manner of goods from friends, family members, and/or strangers. Exchanges involving both special and general-purpose monies are potentially embedded in social relationships to different degrees. The characteristic of embeddedness was long hailed as a divide between western and non-western, modern and pre-modern, market and non-market traditions, but economic theorists now question such a strictly dichotomous view (Cribb 2005, 420; Feinman & Garraty 2010; Maurer 2006, 17). Anthropological models of barter economies, long thought to represent a pre-market evolutionary development, have also been soundly refuted (Graeber 2012, 21–41).

Currency is commonly defined as a state token (Bell *et al.* 2004, 59–60; Graeber 2012, 40–45) and states require taxes and tribute (debts to the state), to be paid in standard materials defined by them, currency being the most explicit form. Debt played a critical role in the evolution of monetary units, due to the need for a unit of account; and both physical token expressions and symbolic representations of such units presented useful solutions (Bell *et al.* 2004, 61; Graeber 2012, 47). As Graeber (2012, 45) observes, 'what we now call virtual money came first' (see also von Reden 2010, 93–4). The lowland Maya revered greenstone as life-giving (Taube 2006) 'virtual money' in rare polished celt form long before jade bead currency became common. Jade as debt, '*ikatz*' or burden (Stuart 2006), endured as virtual money explicitly celebrated in Classic Period treasure carvings. In the Maya area, as for many pre-modern complex societies, inculcating a profound sense of social debt was a concept essential to governance and one of its material manifestations was the payment of tribute (Houston *et al.* 2006, 247; McAnany 2010, 192, 276–8). In the Maya case we have the creation story redacted in the K'ich'e Popol Vuh (Christenson 2007) relating that humans

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were created to nurture the gods, and they were made from maize. We know from Classic references to the same great myth that this was the flesh of the maize god (Freidel & Reilly 2010; Freidel *et al.* 1993). And finally, the gods were embodied, birthed and nurtured by the rulers (Knub *et al.* 2009). The covenantal relationship between Maya rulers and ruled, by way of the creator deities, was such a debt relationship as envisioned by Graeber (2012). While all monetary units are tokens because they are units measuring debt (e.g. taxes, tribute), in cases where currencies were in circulation (as for the Contact Period Maya area), we expect to identify both currency units and more abstract tokens of debt or exchange tallies in the material record. In contrast, abstract tokens may prevail when coinage or other monetary units are in short supply, as for cases known from Medieval England (e.g. Graeber 2012, 45). Freidel and colleagues (2002) argued that *Spondylus* shell was introduced as a sacred insignia of gods displayed as treasure by rulers in the Late Preclassic period and functioned as such an abstract token, or 'virtual money', gradually emerging in the form of bead tokens and currency in the ensuing Classic period. Such issues are important in comparative analyses of economies of the ancient and modern worlds, and here we explore the evidence for accounting practices and their material tools of the trade in Maya societies from around 250 to 1450 AD. Following the model proposed by Graeber (2012) in which the establishment of debt relationships and means of accounting precede and presage the innovation of currencies, we start with an exploration of Classic Maya accounting practices and then move to the matter of currencies.

Accounting practices reflected in Maya art and funerary assemblages

Imagery of Classic Period court scenes depicted on polychrome vases and select murals display transactions of valuable materials and the tools of their reckoning. What artefacts may have aided in counting duties? Tabulation of large quantities of objects would have been greatly facilitated by formal accounts and the use of the place notation system we know the Maya used for calendar calculations. It is unlikely that Maya book-keeping of transactions was done simply by memory, and this point is underscored by the existence of calendrical records from the Long Count dates initiated in the Preclassic Period to the almanacs of Postclassic era codices. It is plausible to infer that Classic Maya authorities using the Long Count would also have used place notation calculation for counting objects. At Contact, Landa (1941, 98) observed calculations in a marketing context: 'they make their counts on the ground or on something smooth'. Tozzer (1941, 98, n. 439) elaborates that tokens were used for this purpose, including shells or possibly cacao beans for ones, and sticks or lines for fives. The Maya and other Mesoamericans certainly knew vigesimal counting, and the Maya still used place notation mathematical calculation when the Europeans arrived. Mesoamerican day counters evidently invented it in the Preclassic as a vertically stacked spatial pattern with real tokens on smooth surfaces, before they filled the empty places with a formal symbol connoting zero (Justeson 2009). Zero was often represented in the writing system as an olive shell (Blume 2011, 53).

Accounting must have mattered to Classic Maya rulers and their courts, whether for commerce, as we suggest, or for tribute (McAnany 2010, 284–5). In addition to bean bundles, Dorie Reents-Budet (2006) makes a clear iconographic case for the importance of woven-cloth currency depicted in large bundles in painted court scenes. At the time of the Conquest and afterwards, cotton cloths of standard length (*mantas*) were currency and tribute items. Bundles of hundreds, if not thousands, of cloths required formal accounting, whether the depicted items were gifts, tribute, or commercial exchanges. So, while perishable Classic Maya textiles most commonly leave only indirect evidence in the form of depictions on polychrome vessels and relatively scarce imperishable spindle whorls, needles and other equipment (Chase *et al.* 2008), the economic importance of textiles likely parallels that of the better known Contact period. Accounting concerning textiles was probably a routine court activity.

As Miller and Martin (2004, 125) observe,

> Although not a single transaction—no record of tax, trade, or census—survives, the Maya probably kept good account of such matters, and would have recorded such items using a pure vigesimal system, that is, without the 360-day feature of the calendar that makes a rough accommodation to solar time.

A good place to start exploring such a prospect is with the artefacts of mathematical calculation. While ordinary sums could have been done with improvised sticks and stones on a cleared dirt surface, it is unlikely that the art of calculation in Classic Maya courts, whether for sacred calendar prognostication or for the more prosaic tasks of accounting, would have been undertaken with such humble improvisations. Consequently, scrutiny of images, texts and elite archaeological contexts that might hold evidence of courtly artefacts relevant to calculation is in order.

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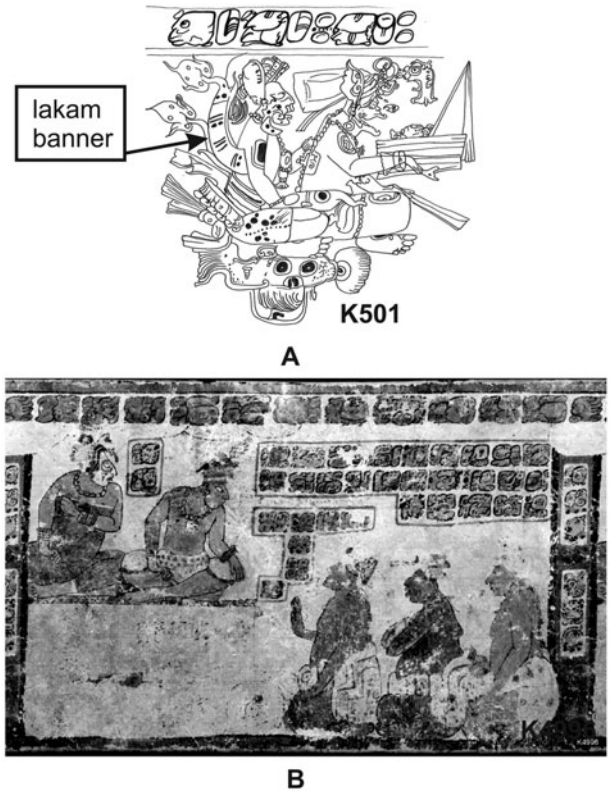

Figure 1. *Big banners on polychrome vessel scenes (A) K501 (Drawing: Kendra Farstad from a photograph, courtesy of Justin Kerr); (B) K4996 (photograph courtesy Justin Kerr).*

Big number banners

How do we begin to identify the Classic courtiers responsible for calculating big numbers—those who were the literal bean counters? There is a scribal figure in the vase corpus relevant to this challenge. On K501, for example, a seated Monkey Scribe deity has a print-out banner or number banner (Coe 1978; Coe & Kerr 1998) emerging from under his right arm (Fig. 1a). Knub and colleagues (2009) summarize discussions by Houston and Stuart (1998), Stuart and colleagues (1999) and Zender (2006), and observe that the decipherment of this number banner in texts is AN, meaning leaf. Zender (2006) suggests that the number banner refers to *anahte'*, also *analte'*, which Villaguiterrez y Sotomayor identifies as the term for book in the Itza nation of Petén. In that reference the books evidently recorded history, but the Spanish priest Avendaño used these books to show that the Itza should convert to Christianity. They included, then, calendar almanacs of the kind preserved and sent to Europe. The numbers on the banners are bar-and-dot stacks, but they are not Long Count dates that also feature such stacking place notation. However, they may reference numbers that appear calendrical in nature (John Justeson pers. comm. to Marilyn Masson, 2013). We would suggest that the number banners could identify the wearers as book-keepers in our sense of that role, specialists in the calculation and recording of big numbers. Certainly they denote scribes as suggested by Coe and Kerr (1998).

With regard to specialists in big numbers, Alfonso Lacadena (2008) has advanced the argument that *lakam* as a title refers to courtiers with administrative responsibilities regarding tribute, among other things. Stuart (2010) identifies three courtiers presenting tribute on K4996 as '*ux lakam*' [three *lakam*s], with the suggestion that this is a family name (Fig. 1b). We suggest they were indeed officials of the kind identified by Lacadena (identified with the T767 glyph) and that they were responsible for not only calendrical calculations but also for tabulating large numbers of items. McAnany (2010, 285) identifies such a personage with a 'long tally scroll' as an accountant. This big number role appears to have survived the Classic–Postclassic threshold and persisted among the Maya, suggesting continuity of the accounting practices we are investigating. Susan Milbrath and Carlos Peraza (2003) reported on a remarkable Late Postclassic effigy censer from Mayapan that depicts a Monkey Scribe god. The deity is holding a shell paint pot in his left hand and a brush in his right. He has scrolled number banners emerging from behind his arms. These banners are painted with yellow fields and blue borders with black bar-and-dot number stacks (Milbrath & Peraza 2003, fig. 7). Coming out of his open mouth is a third number banner painted in the same fashion. Here it is quite clear that the number banners on the back are insignia of a deity who is a big number counter and declarer. This is not a unique occurrence: plate XXXIV in de Rosny's (1883) publication of pages from the Madrid Codex depicts a god in the lowermost register with a stylus and shell paint pot in hand and a number banner coming from his mouth (Milbrath & Peraza 2003, fig. 6). He is clearly a scribe who is a big number counter. But if there are scribe accountants, both in the Postclassic and in the Classic, we have yet to define their particular calculating tools. The epistemological challenge, in the face of such an apparent paucity of artefactual evidence concerning the activity of counting and accounting, is to try to recognize new patterns in the data we have available to us.

Counting tokens

In light of the explicit evidence that the Classic Maya counted cacao beans (Stuart 2006), it is possible that the carved shell effigy cacao beans from Ek Balam,

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Yucatan, Mexico (Miller & Martin 2004, 86, pl. 37) are such elaborated counting tokens. These rare artefacts provide a clue as to what archaeologists might look for in patterns of elaborated counting tokens (beyond the iconographically ambiguous shell and stone beads which likely served such a purpose), specifically, artefacts that are plausibly associated with counting and the scribal arts. McAnany (2010, 277–8) similarly proposes that large volumes of maize transfers were symbolically alluded to by the regularly occurring vessels filled with tamales in Maya court scenes where exchanges are taking place. Furthermore, sharing meals is also a cross-culturally common practice that eases the tensions of payments of debt or other potentially conflictive exchanges (Graeber 2012, 101, 118).

We think it safe to postulate that, if there were Classic period court accountants, they were literate as well as numerate. Iconographic analysis of scribes in court scenes can support this, but first we consider some of the evidence from Burial 39 at El Perú-Waka' in northwestern Petén, Guatemala (Rich 2008; 2011; Rich *et al.* 2007). The offerings in Burial 39 make clear that this ruler was identified with the scribal arts, like others discovered at Waka', including Burial 37 (Escobedo & Meléndez 2007; Freidel & Escobedo 2007). Michelle Rich (2011) has analysed in detail the materials associated with Burial 39, which dates stylistically to the middle of the seventh century AD and contains a ruler in a prone position (Fig. 2). Above the head of the deceased were arranged two lip-to-lip ceramic vessel bundles and two concentrations of artefacts that may also have been bundled in perishable containers. One of the concentrations contains 60 small and elaborately carved stone and shell spindle whorls (Fig. 3a). Spindle whorls are fairly rare in the Classic Period Maya archaeological record. For example, Arlen Chase and colleagues (Chase e*t al.* 2008, 130) recently reported a modest total of 57 spindle whorls from the Classic Maya site of Caracol, Belize. The size of the Burial 39 whorls is comparable to the smaller Caracol examples, roughly 2 cm in diameter. However, in both dimensions and elaborate carving, they parallel 12 whorls found in a royal tomb dating to AD 537 located in Structure B20 at Caracol (Chase *et al.* 2008, 134, fig. 2). The Caracol investigators point out that, while whorls might be presumed to be associated with women as weavers, the elite burials at Caracol that contain whorls are not directly associated with any individual male burials, but do occur in interments with multiple individuals of both sexes, and two burials described by Chase *et al.* (2008, 136) as 'single individual female sexed and/or gendered interments'. In the case of Waka' Burial 39, there is no direct skeletal evidence of the sex of the interred, but there are three royal epithets painted or inscribed on offering vessels, and none of them suggest female names. Moreover, a remarkable and unique scene of 23 ceramic figurines arranged in a tableau at the foot of the deceased individual (Freidel *et al.* 2010; Rich & Freidel 2010) depicts a funeral ceremony in which the dead ruler is evidently portrayed as a male Maize god impersonator. The iconographic record of bundled cloth transactions (Reents-Budet 2006) is clear: these are primarily between men, although women sometimes occur in auxiliary roles. Under these circumstances, Burial 39's association with weaving is less likely to be with the production process, but rather the product itself, namely cotton cloth. We therefore posit that the miniature elaborate spindle whorls reference the counting of cloth. As discussed later in this chapter, standard lengths of cotton cloth were units of currency in the Contact period, certainly subject to counting.

Concentrations of spindle whorls such as this are very rare, yet this is one of two in tomb contexts at El Perú-Waka' and a total of four of which we are aware in the Maya area. The others are in Waka' Burial 38, a Classic interment contemporary with Burial 39 (Eppich 2007; Eppich & Rich 2007), the aforementioned royal burial in Caracol Structure B20; and a possible ritual offering of more than 200 broken limestone whorls discovered at El Pilar on the Belize–Guatemala border (Kamp *et al.* 2006). However, as we summarize in this paper, shell currency tokens at the time of the Contact were measured in spans, presumably strung like beads. While bead strings are a common occurrence in Classic Maya imagery, and beads as noted are functionally ambiguous, there are strings of other objects represented on painted vessels that are widely accepted as earflares. These strings of asymmetrical objects sometimes ornament a ritual chain extending from the belt of a ruler and ending in an image or symbol of the rain god Chahk. Earflares are symbolic flowers in Maya iconography, and the elaborately carved spindle whorls found at Caracol and El Perú-Waka' include many that display the symmetrical petal patterns of flowers or seedpods. Notably, the depiction of earflare chains is much more common than the reported discovery of earflare concentrations in archaeological contexts, although one such concentration was found, along with large collar beads and diadem jewels, in an Early Classic cache at Yaxuna in Yucatan (Stanton *et al.* 2010). Classic regalia earflare chains, in a conservative interpretation, depict wealth with possible religious connotations of flowers, and we suggest there is a potential to identify an additional layer of meaning as possible counting tokens.

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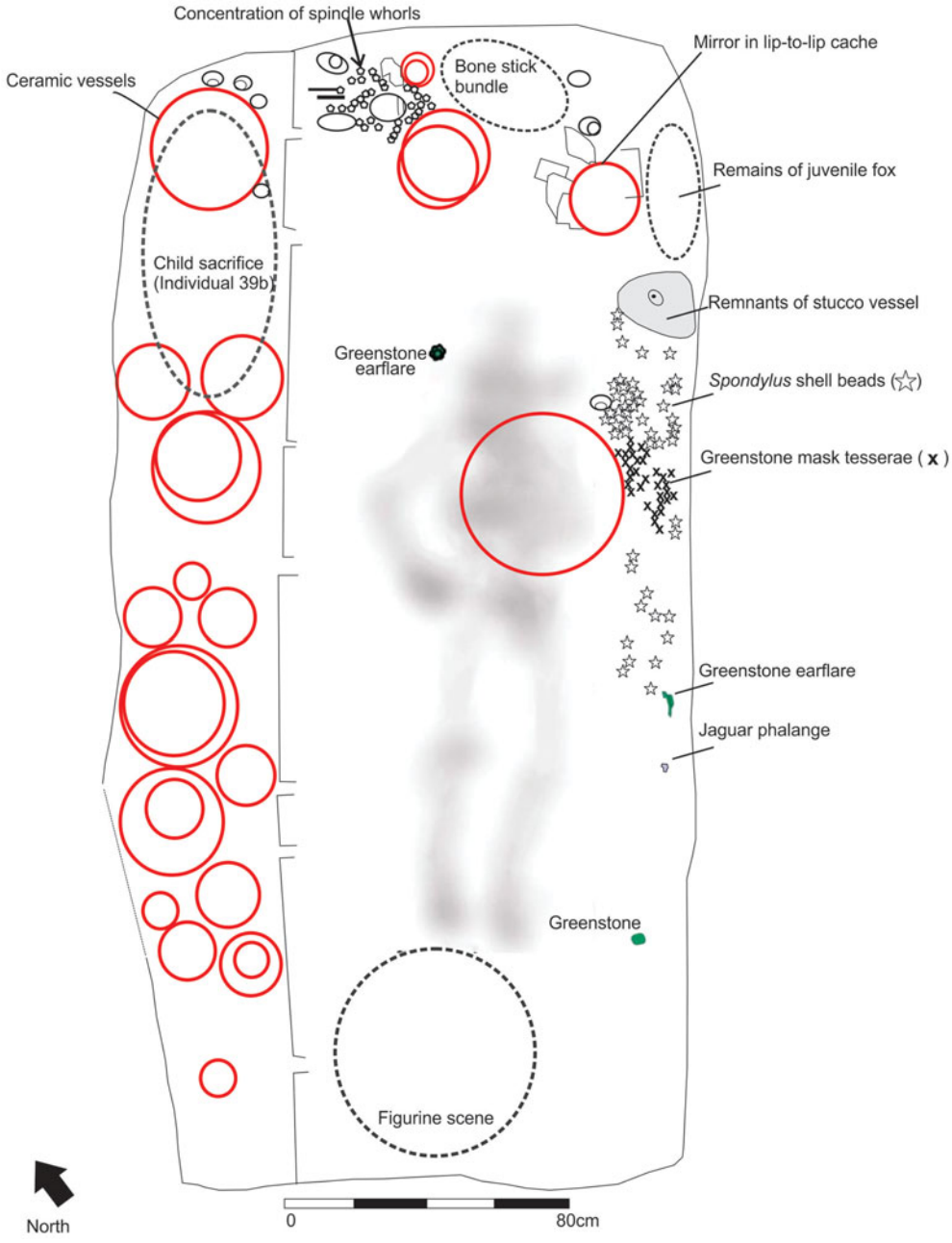

Figure 2. *(Colour online) Preliminary drawing of El Perú-Waka' Burial 39 highlighting various mortuary objects discussed in text. Shaded image denotes general location of human skeleton remains. Not all objects comprising the mortuary assemblage are included. Ceramics are depicted whole, but were broken* in situ *when the tomb was infilled after re-entry. (Drawing: Michelle Rich, Jennifer Piehl & Varinia Matute; redrawn by Marilyn Masson).*

Another possible kind of token found in Burial 39 is a small flat, circular *Spondylus* shell object pierced for sewing or suspension. A concentration of these spangles was located adjacent to the left side of the body and next to the remains of a small greenstone mosaic mask (Fig. 2). We call these 'spangles' because Héctor Escobedo and Juan Carlos Meléndez (2007) found a pattern of these shells (Fig. 3b), along with greenstone spangles of the same general form, next to a round slate-backed mosaic mirror in Burial 37, another royal tomb at El Perú-Waka'. Escobedo identified this pattern as the remains of a headdress, and it is conceivably the first spangled turban ever detected in a royal tomb (Freidel & Escobedo 2007). Spangled

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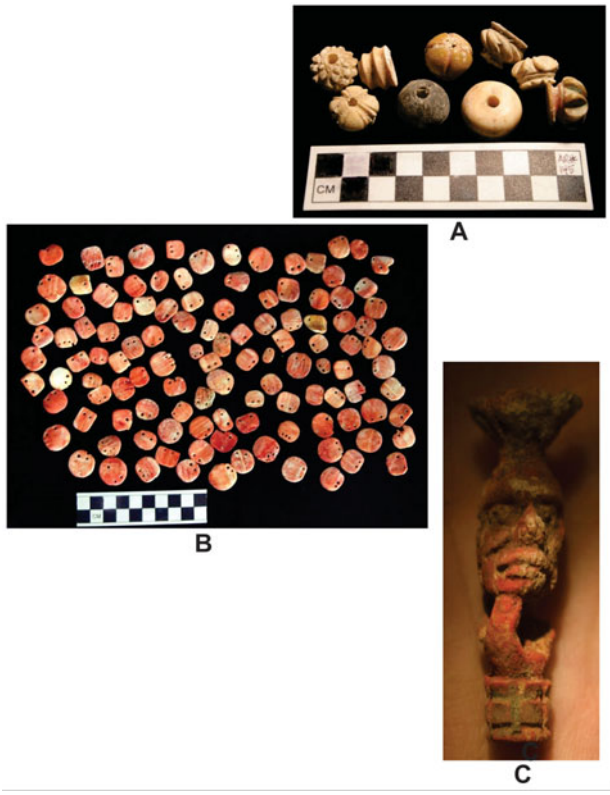

Figure 3. *(Colour online) Tokens and a carved bone stick: (A) examples of 60 miniature spindle whorls (most <2 cm in diameter) from El Perú-Waka' Burial 39 (Photograph: Michelle Rich); (B)* Spondylus *tokens from El Perú-Waka' Burial 37 (Photograph: Juan Carlos Meléndez); (C) carved bone stick end from the bone concentration in El Perú-Waka' Burial 39 (Photograph: Varinia Matute).*

Figure 4. *(Colour online) Stick bundles and mirrors (A) K1790 and (B) K8019a (Photographs: courtesy Justin Kerr); (C) a stylus-carved sherd from a tecomate-style vessel inscribed with a royal name 'Ak'ab Bahlam' from El Perú-Waka' Burial 39 (Photograph: Michelle Rich).*

turbans are regalia of scribes and sages in Classic Maya iconography. In addition to the concentration, other shell tokens of this kind were scattered on the funerary bench. While these items were pierced for attachment, their standard size and shape would have made them ideal as counting tokens.

Counting sticks

Imagery representing singular or bundled sticks is abundant in Maya art, and Michael Coe and Justin Kerr (1998) have suggested that these stick bundles might be quill pens used by scribes. There are numerous examples representing the end results of work conducted by scribes that speak to the diversity of stick-like painting, writing and inscribing tools that could have been used by scribes in different contexts. Vase painting would have been accomplished with brushes, whereas incising harder objects would have been carried out with engravers. As it happens, there is clear evidence of writing with a sharp stylus in Waka' Burial 39. A plain brown burnished ceramic tecomate-style vessel had a double line of black paint around the rim, and a scribe experienced with the writing instrument used a sharp stylus to inscribe names of rulers and gods between the lines (Fig. 4). Quill pens, on the other hand, would have been appropriate for writing and accounting in bark paper books.

It seems that many of these implements were fashioned of highly perishable material, perhaps carved and painted wood, if not the feather quills suggested by Coe and Kerr. Bone is another material from which to fashion sticks, and such examples do exist in the archaeological record. As with the array of styluses or inscribers that must have been used by scribes, there is no singular category of bone stick into which all objects of this nature exclusively fall. The general lowland Maya corpus of these fragile and often poorly preserved bone objects has yet to be inventoried and collectively examined. Such work may potentially distinguish between bone

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objects that served as needles, styluses, hat pins, spatulas, counting sticks, or other (tentatively overlapping) functions.

Returning to the bundles north of the head of the deceased in Waka' Burial 39, a concentration of carved bone sticks is adjacent to the cluster of previously discussed spindle whorls, seemingly representing a stick bundle. Badly broken, possibly by the re-entry events of the eighth century, hundreds of bone fragments likely comprise dozens of sticks that require extensive conservation, and appeared *in situ* to be of the order of 15–20 cm in length. The sticks are lenticular in cross-section, and thin and delicate. Some are incised with a line swirling around the shaft, but none are incised with glyphs. Some of the sticks have two intricately carved ends and others have a needle tip. The elaborate bone sticks in Burial 39 resemble the 'hat pins' stuck into the turbans of scribes depicted on painted vessels, which often have hands or brushes on their tips. Such pins, however, occur in small numbers on any given turban, not in the prodigious concentration represented in the Burial 39 offering. In accord with imagery on the painted vessels, the carved ends of the Burial 39 bone sticks portray different motifs, including brush tips, hands holding various objects including flowers, leaves, shells or cacao pods with human faces inside them, birds and masks (Fig. 3c). The iconography of hands holding masks clearly identifies these artefacts with scribes. Eric Boot (2006) has analysed texts on several painted vessels depicting scribes holding masks and suggests that the verbal action is u pa-k'a-wa or *u pakaw*, which he glosses as 'to shape', representing the act of carving. While in one instance the scribe in question is clearly holding a long instrument that might be a carving tool, in the great majority of representations of scribes holding masks, the act is merely contemplation or display. So we suggest that the meaning is likely metaphorical in most instances. While 'shape by hand' is certainly a fair reading in light of contemporary Mayan related words, another reading is 'arranged by hand'. Both of these would, as metaphors, work to describe the actions of scribes calculating mathematics with tokens (ones) and sticks (fives) or constructing texts.

We believe the relationship between sticks and inscribing or drawing suggested by Coe is a real one, and several of the carved ends of the bone sticks in Burial 39 do symbolically depict paintbrushes. However, we note that in the stick bundles depicted in the vase corpus (e.g. K1790) there is a pattern of the sticks being painted white with red tips. This colour scheme is roughly commensurate with the white bone sticks with painted ends in the Burial 39 offering. Although Maya codex books include red and other colours, the primary colour associated with book ink is black. Moreover, stick bundles occur as multiple objects offered to lords in bowls (e.g. K1790), and quill pens strike us an unlikely offering (Fig. 4a). Here we think that the stick bundles stand for amounts (there is a bundle of cloth on the lower register of this palace scene) and that, more generally, the sticks in stick bundles are calculating tokens that stand for fives and also provide the spatial means for positional notation. Further archaeological examples found in elite contexts have been classed as bone needles or pins, and can be reconsidered in the light of the possibility that they may be multi-functional and also represent stick bundles. For example, K8019a-d in Kerr's Precolumbian Portfolio (Fig. 4b) illustrates carved and inscribed bone pins of suitable size and number to be real or effigy counting stick bundles, which are presently identified as perforators or weaving sticks. Stephen Houston's drawing and interpretation of the text is also available on the website. These bones are discussed in great detail by Dacus (2005, 15), who illustrates each of the 24 carved bones, indicating that 'inscribed with glyphs describing them as *u puuhtz'* and *u puuhtz' b'aak* or "the needle of" and "the needle bone of," the bones also give us the name of a royal lady as the owner.' Some of these are virtually identical to those found in the Burial 39 deposit, which are greater in number and demonstrated more variety in stick shape and form (e.g. double carved-end sticks described above).

Additionally, there are several examples of pointed bone objects from recorded Classic Maya mortuary settings. The most famous stick bundle was discovered in Tikal Burial 116, the tomb of Jasaw Chan K'awiil M (Moholy-Nagy & Coe 2008). Like the ruler in El Peru-Waka' Burial 39, the deceased in Tikal Burial 116 was accompanied by insignia of scribal status, in this case a ceramic effigy shell paint pot placed above his head. The bone stick bundle by his right hand is symbolic, as the elaborate incised scenes and texts relate to Jasaw Chan K'awiil's metaphorical death and resurrection as the Tikal Maize god (cf. Freidel & Guenter 2006), and to intriguing historical events, including the death of a king of Dos Pilas and the capture of a nobleman of a Kaanal king. Such historical matters may well have been in the domain of royal divining and numerical calculation related to the sacred calendars. Finally, a bundle of nine small carved bones (6–12 cm) was discovered at the foot of the individual in Tomb 2 underneath the floor at the south end of Structure 23 at Yaxchilan (Miller & Martin 2004, 112, pl. 55). David Stuart (2013) has deciphered texts on two of these bones and shown that one of them names Queen K'abal as the owner, and

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also a principal tutelary deity of Yaxchilan, named Aj K'ahk' O'Chak, as the divine being associated with this 'jaguar bone'. As Stuart notes, the carved head of this bone resembles Chak. He further notes that the bone point is blunt and not suitable for functioning as a blood letter. While such artefacts may have served other purposes, they are of a size suitable for the function of stylus incising on a soft surface. In this Yaxchilan case, we have the explicit depiction of Queen K'abal on Lintel 25 of Structure 23 observing a conjured animate and anthropomorphic bundle (identified as a deified ancestor by Schele & Freidel 1990) containing the flint and shield of war, Tok Pakal, while the text above declares that her husband conjured this flint power as Aj K'ahk' O'Chak. As Stuart says, the name of Queen K'abal's bone is Tok Ajaw, Flint Lord, offering. As noted below, the conjuring of a tutelary deity in a figurine assemblage discovered by Rich and her colleagues in Burial 39 at El Peru-Waka' is accompanied by stylus-wielding scribal observers who bear writing tablets. It would make sense if K'abal's personal bone were her stylus for recording the vision on Lintel 25.

Writing palettes

A final category of relevant artefact from the Waka' Burial 39 mortuary assemblage is a lip-to-lip cache offering featuring a broken square slate-back mirror surface, found above the head of the interred ruler (Fig. 2). While Classic mosaic mirrors are not uncommon, most are circular, as are mirrors in Waka' Burials 37 and 38. Mirrors appear frequently in vase scenes depicting scribes, and in general they show principal individuals looking at their surfaces. This rectangular mirror may relate to the distinctive writing palettes held by four individual scribe figurines in the Burial 39 narrative scene (Fig. 5; Freidel *et al.* 2010). This object is a rectilinear palette either cradled in an arm or with an actual hand-hold cut out of the surface. The palettes all have yellowish painted surfaces lined by blue borders. The individuals in question are also holding single thick, stylus-like objects comparable to the one handled by the Monkey Scribe effigy from Mayapan described above. These are likely sticks that function as both styluses and counting sticks. We think it is reasonable to propose the stylus-palette combination refers to calculating and writing.

There is a similar figurine in the Kerr corpus, K8566, and this male individual holds several sticks in the right hand and a rectangular palette in the left (Fig. 5a). These objects are identified by Kerr as possible weapons and a shield, but the sticks are of the same small scale as the styluses depicted with the scribe figurines in the Burial 39 scene. In the case of

Figure 5. *(Colour online) Figurine with palette (A) and a figurine (B) from El Perú-Waka' Burial 39 equipped with a writing palette and stylus; (C–E) mirror and palette scenes on polychrome vases. (Photograph B: courtesy Ricky López. Photographs A, C, D, E: courtesy Justin Kerr).*

K8566, the palette is not painted, but the surface is bordered with a twisted cord and rosettes in the four corners. While we can find no unequivocal examples of writing palettes in the painted scenes on Classic Maya pottery, there are in fact several instances of mirrors being associated with stylus-like objects (Fig. 5c–e: K4096, K6437 and K8793), and others have suggested that flat, rectangular surfaces in Maya art were tablets on which tallies were registered (McAnany 2010, 284). In the case of K4096, the mirror is clearly rectilinear and it has a border divided into segments that look like the twisted cord motif on the object held by K8566 (Fig. 5a). We should note that the conventional surface colour of mirrors in the vase corpus is black, while the majority of known mirror artefacts have pyrite crystal mosaic surfaces that are golden yellow when not corroded. Given the yellowish painted surfaces of the palettes in the Burial 39 figurine tableau, and the unusual square shape of the mirror at the head of the ruler in the tomb, we propose this may be an

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actual working model of such a palette as a royal artefact.

How would such a palette actually work if it was surfaced with pyrite or other mirror material like volcanic hematite? If the surface were primarily used as a smooth, flat surface for calculating, we would expect to find images of such palettes (or mirrors) placed horizontally. There are a few such possible examples (K624, K717). The utility of such a palette would be a surface that was contained so that the tokens would not be scattered or the calculation lost. However, in most depictions of mirrors they are raised at an angle and backed by a round or cylindrical object like a pot. The usual explanation is the obvious one: the most important individual in the scene is either just getting a look at his image or is divining. However, Michael Coe (pers. comm. to D. Freidel, 7 May 2010) has suggested that the Maya may have coated the surface of such palettes with beeswax and written on them with a sharp stylus, analogous to writing boards in the classical Mediterranean world. As such, the golden colour of palettes in Burial 39 may be a device to reference the perishable beeswax writing surface.

In the same correspondence, Coe suggested that there might be examples of writing palettes in the Madrid Codex (de Bourbourg 1869–70; de Rosny 1883). We think he is correct, and that the so-called 'bee pages' contain numerous examples of golden-coloured palettes with bees on them and also palettes with the glyph *cab* standing for bee (Mathews 1993), or, we would suggest, beeswax. On plate IX of de Bourbourg's publication, we suggest that the upper register shows gods with beeswax palettes in their hands and stone-marked counting trays below on the ground; the middle register shows four golden yellow surfaced rectangular items with bees on them that we interpret as waxed palettes; and the lower register shows gods holding bowls full of yellow round objects (Fig. 6). In the centre of the lower register, the god has a stylus next to him and a palette marked *cab* and with horizontal lines on it. On the right-hand side of the lower register, the god has a *cab*-marked palette and below that a stone tray. On plate II of de Bourbourg's publication, in the upper register two gods are writing with styluses on rectangular *cab*-marked objects we identify as wax-coated palettes (Fig. 6).

The advantages of such a practice of wax surfacing calculating palettes, particularly with regard to 'scratch' notations associated with numerical calculations, is the saving on expensive and labour-intensive plastered bark paper. The Maya certainly had beeswax as a commercial product and used it for a variety of purposes (Piña Chan 1978). The advantages of a mirror surface for high elite palettes would include being scratch-proof and easily cleaned and resurfaced with fresh wax. This reasoning requires material testing of the surfaces of the mirror offering here and in other contexts to see if organic traces commensurate with beeswax can be discerned. Unconventional as this prospect sounds, it would make better sense for high lords to be checking the numbers rather than divining in the several scenes showing them peering into mirrors in the midst of what are obviously transactions involving quantities of goods (e.g. Fig. 4, K1790; Fig. 5, K4096; Fig. 7, K625, K2914).

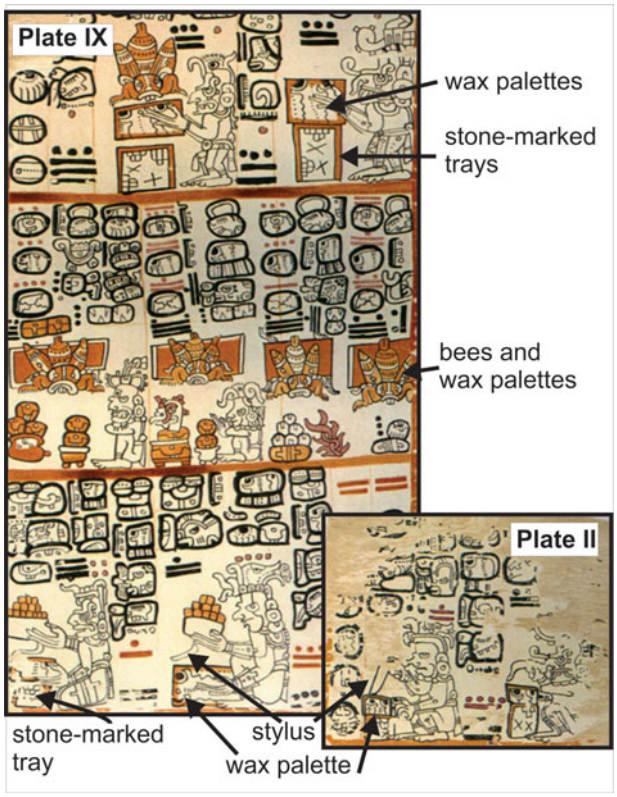

Figure 6. *(Colour online) Madrid codex wax palettes, stone trays, stylus. (de Rosny 1883, plates IX, II.)*

Maya calendar studies are more than a century old, and we have always known that the Classic Maya took their counts of days very seriously as an elite activity (Rice 2009). If we are to make real headway with the matter of Classic Maya political economy, we must begin to recognize patterns in the data available to us that are relevant to the activity of counting and calculating large numbers. Beyond calculating large numbers, an established fact not only for days but also now for cacao beans (Stuart 2006), the Classic Maya of the royal courts must have had ways of writing them down, both provisionally and permanently. We have outlined some possible ways of identifying artefacts

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Figure 7. *(Colour online) Lords, mirrors, and transactions involving goods. (Photographs: courtesy Justin Kerr.)*

germane to such activities. If we are on the right track, there will be other patterns forthcoming as colleagues put their minds to this matter. Like Edgar Allan Poe's 'purloined letter,' some archaeological patterns are sitting out in plain sight, cleverly disguised as themselves. This may prove to be the case with counting tokens and the provisional inscribing of calculations. It is certainly the case with currencies, to which we now turn.

Shell money

We have already observed that some prospective calculating tokens, such as effigy shell cacao beans and miniature spindle whorls, were likely designed to reference currencies like real cacao and lengths of cotton cloth. We have also noted that calculating sticks and stylus sticks serve as regalia in the headdresses of numerate individuals, including royalty. In the case of the *Spondylus* and jade spangles or disks found in royal tombs at El Perú-Waka', the potential correspondence between regalia, calculating token and currency unit encourages us to look at ritual regalia with this kind of connection in mind. Freidel and his colleagues (2002) proposed that *Spondylus* emerged in the Late Preclassic period as a treasure and currency material with assertions of its value and importance expressed in the display of ritual regalia on deity images ornamenting public monuments. The 'sticks and stones' of large number calculation, similarly, could well be represented in the tubular and spherical jade beads of the netted skirt worn by the 'Holmul Dancer' figures (Reents-Budet 1991) representing the Maize god, and also by the Moon Goddess. In the same manner, the famous jade bead collar of Tikal King Jasaw Chan K'awiil discovered in Burial 116 (Coe 1990, 606) is composed of rectangular elongated and spherical beads that are glorified sticks and stones.

Shells, scribes and nobles

Shells other than *Spondylus* occur as regalia expressing scribal functions or statuses such as royalty or divinity. Justin Kerr (n.d.; Coe & Kerr 1997, 148) argues that scribes, both human and divine, wore shell paint pots in their headbands. Some royal crowns discovered in archaeological excavations were fashioned of segments of carved and polished white conch shell pierced for sewing onto a woven textile headband. In Early Classic Yaxuna Burial 24 at Yaxuna in Yucatan, archaeologists discovered such a crown *in situ* near the head of a sacrificed young woman with a greenstone huunal jewel at its centre (Fig. 8a, b), along with three burnt segments of such a shell royal crown at the foot of the central deceased individual in that tomb (Ardren 2002; Stanton *et al.* 2010; Suhler & Freidel 1998). With this secure archaeological context in mind, we can further identify the three long segments of carved conch shell from Proyecto Nacional Tikal Burial 019 as part of a crown in this posited royal tomb (Laporte & Fialko 1995), and also conch-shell segments from a Classic burial discovered at San Gervasio, Cozumel Island, with a remarkable Olmec-style heirloom jade as the huunal jewel (Freidel *et al.* 2002; Rathje 1973). These associations of royals with shell objects call to mind von Reden's (2010, 15) statement regarding the sacred dimensions of money and kingship in western antiquity: 'Instead of representing a traditional, backward-looking element in ancient economies, both temples, and kings and emperors acting as religious figures, integrated money into their economies and bestowed upon it a symbolism that was favourable for its circulation.'

Olive shells (*Oliva* sp.) arranged in fours as the k'in (day) glyph decorate the headdress on a Classic period jade carving (Fig. 8d, K1505), and also on the headdress of the so-called 'decapitator god', famously represented by an effigy censer (Fig. 8e, K4884) in Tikal Burial 10 (Coe 1967). In our view, this aged deity is not holding a severed head, but rather a mask of the kind displayed by scribes as discussed above. If we are correct, then this deity is 'arranging' or 'ordering', and we propose that the olive shells on his headdress underscore this activity by depicting tokens gathered

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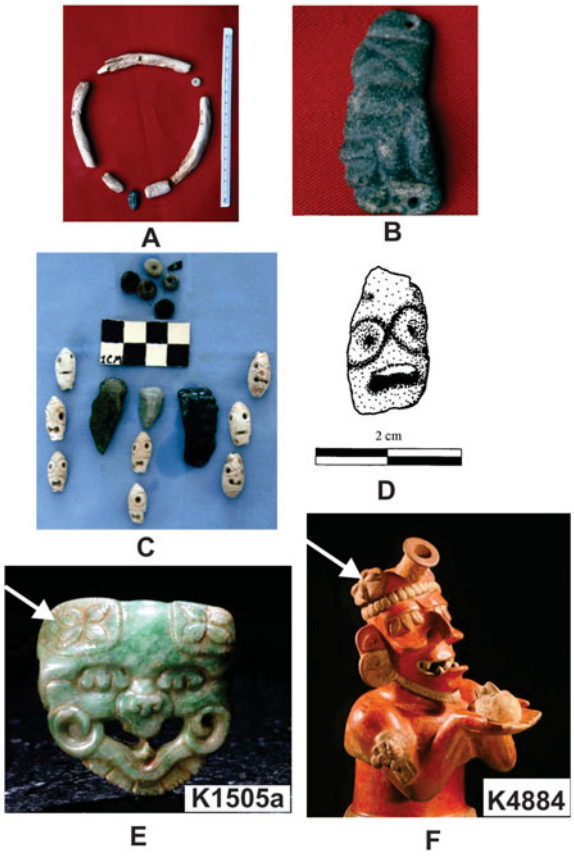

Figure 8. *(Colour online) Royal jewels: (A) royal crown of cut conch and a jade jewel, Burial 24, Yaxuna (Early Classic); (B) the 'Decapitator' God, Burial 24, Yaxuna; (C) jewels and olive-shell skulls, Burial 24, Yaxuna; D) skull tinkler carved from Spondylus, Burial 23, Yaxuna; arrays of olive kin sign arrangements on a jade ornament (E) and on a figurine from Tikal (F). (Photographs E & F: courtesy Justin Kerr.)*

and arranged as Maya diviners today gather and arrange casting tokens in ordered piles when prognosticating (Brown 2015). As such modern prognostication often involves calendrical calculating, the k'in symbol is perhaps signalling this intention in the Precolumbian setting. Olive shells also served as belt ornaments on many performers, royal and non-royal, depicted in the Classic period, presumably as percussion instruments. Freidel and Suhler (1998; see also Stanton *et al*. 2010; Suhler & Freidel 1998) observed another young royal woman in Yaxuna Burial 24 with a necklace on her chest (Fig. 8c) composed of olive shells carved as skulls, along with three jade jewels including a huunal jewel of royal majesty, a 'Charlie Chaplin' dancing figure and a profile schematic representation of the aforementioned 'decapitator god' with cartouched crossed bands representing the olive shell cluster in his headdress (Fig. 8b).

There are many other examples of olive shells carved to represent skulls in the Maya archaeological record, no doubt inspired by their bony colour and shape. However, the significance of this skull representation transcended colour: there was an effigy olive-shell skull carved in red *Spondylus* in Early Classic Burial 23 (Fig. 8d), another royal tomb at Yaxuna (Stanton *et al*. 2010.) Yaxuna Burial 23 also contained two concentrations of shell tokens, 37 limpet shells (three painted red on the interior) and 40 small cowrie shells (Fig. 9). A large cowrie was found next to these concentrations, which were adjacent to the head of the deceased. We suggest that these were also likely calculating tokens such as posited for the artefacts found at El Perú-Waka'. Returning to olive shells, the ancient Mayan word for bone, *bak*, is homophonous for the word for heron in some Mayan languages (Stross 1985). One Classic Maya cylinder vase (K6218) is painted with white water birds that look like herons (see Taube 2010, 208, fig. 10 for a comparable bird painting identified as a heron). K6218 is further ornamented with olive shells in strings and in clusters of three. Clusters we have already discussed. Strings are germane to the argument we now present that olive shells were not only regalia and tokens, but also currency reckoned in spans of shells and of beads.

Cowries and olive shells as monetary units and as ornaments

Confusion regarding the general-purpose status of shell monies for the Maya realm arises from the considerable variation in use of shell monies in cross-cultural cases of the ethnographic record, and the common view that they were usually prestige goods (e.g. Trubitt 2003, 244). Maya states are not directly comparable to small-scale societies for which many shell exchange traditions have been made famous in their contributions to theories of sociocultural evolution. Whether or not they developed into standardized money items in other societies, recurring shell taxa had cross-cultural appeal as valuables, including various cowries, *Conus*, *Oliva*, *Spondylus* or *Chama* (another red spiny marine oyster), and conch in parts of Oceania, Africa, the Caribbean and California (e.g. Fenenga 1988; Keegan & Carlson 2008/2009; Quiggin 1949). Cowrie money has great time depth and geographic distribution from Asia to Africa (e.g. Einzig 1949, 147–51; Quiggin 1949, 25–39).

Cowries were a rare and prized material only occasionally used in ancient Maya sites and then often deposited in tombs or caches (e.g. Chase 1992, 36). A large piece of worked and pierced deer cowrie was

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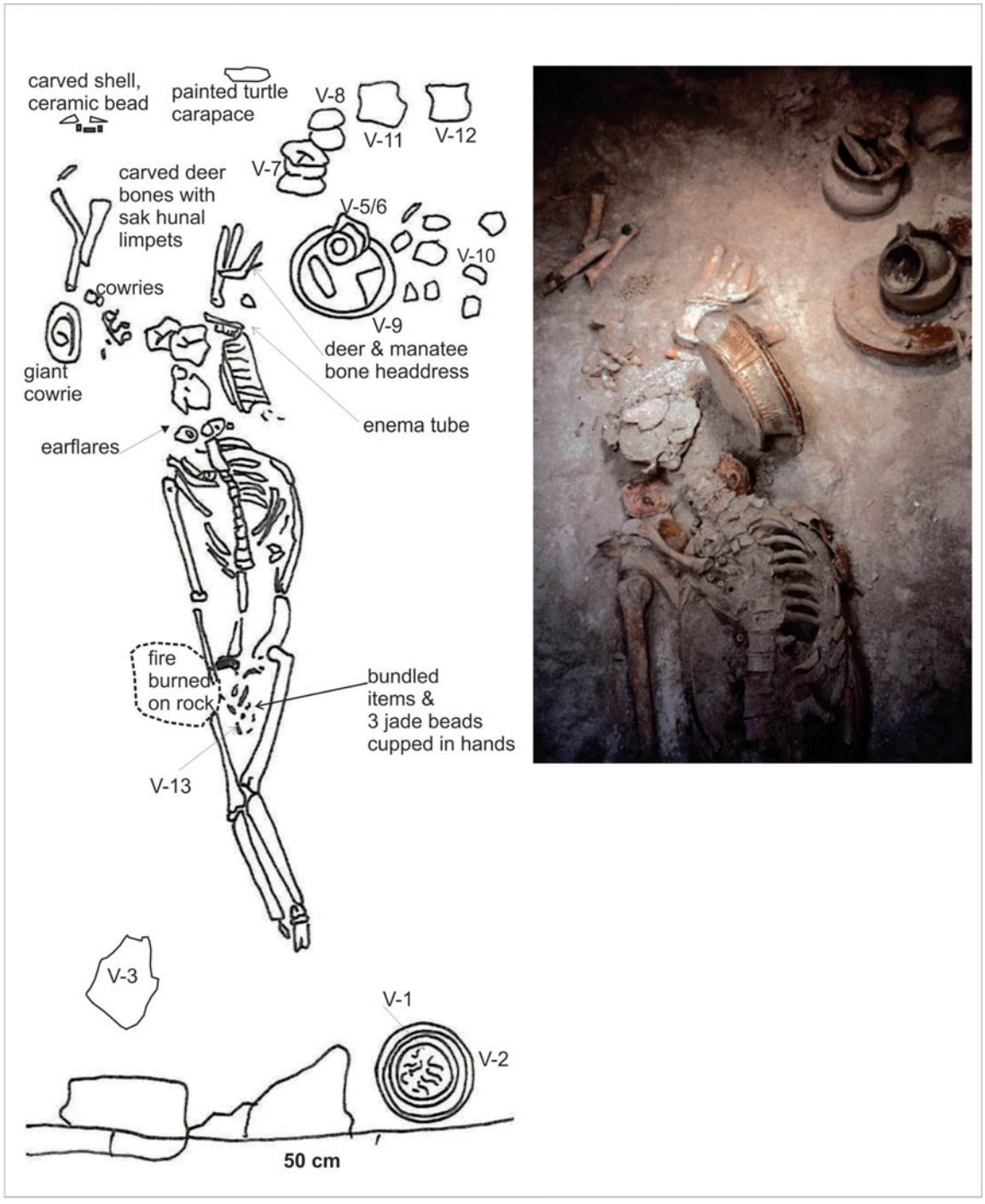

Figure 9. *(Colour online) Burial 23 from Yaxuna showing limpet and cowrie shell concentrations above the head. (Modified from David Freidel's original illustration by Kendra Farstad.)*

placed next to the carved bone bundle in El Perú-Waka' Burial 39, for example. We infer that olive shells (and closely similar species) functioned in a manner analogous to cowries elsewhere in the world and were part of a Maya shell-money system that also included beads and plaques of thorny oyster (*Spondylus*) and certain white shell objects. Olive shells also gained the status of money elsewhere in world history. In coastal California, olive shells were significant for monetary purposes on the eve of European arrival (Arnold 1992,

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73) and in the sixteenth-century kingdom of Congo, olive shells rivalled cowries in importance (Quiggin 1949, 298). However, even the renowned cowrie shell varied in its usefulness as a general-purpose money over time and space (e.g. Johnson 1970, 18, 26; Ogundiran 2002, 434; Yang 2004, 306–8).

As in the case of the Maya, other pre-modern state societies, notably those that employed cowries, used shells for a wide range of commercial and governmental accounting needs. The sacred symbolic status of shell objects for Maya society, and the fact that they were also worn as ornaments, in no way disqualifies them as monetary units, not simply due to the fact that shell beads were used as general-purpose monies upon Spanish arrival to the Yucatan peninsula, but also because the sacred and prestigious aspects of shell contributed importantly to reinforcing their value (Freidel *et al.* 2002). Money, cross-culturally, assumes its value from the top down, with worth constituted and reinforced by elite sanction, whether the monetary unit is a shell, a coin, or a banknote (Cribb 2005, 425). Not all shells in use for the Maya or other societies were equally valued or used as currencies.

In areas where monies varied widely among interacting trading cultures over considerable distances, common units of value were used to standardize different currencies like oxen, cattle (Quiggin 1949, 272) and 'stockfish' or dried cod (Quiggin 1949, 285). Cacao beans may have functioned similarly across Mesoamerica and into Nicaragua. Quiggin (1949, 280) notes that 'one of the essential functions of money is that it is a sign of wealth.' Thus she notes that money in all its forms can be displayed as personal adornment, and larger, more exquisite and unique objects may be wealth items whereas their smaller, less elaborate counterparts served as money (1949, 258). Shell and metal currencies also commonly serve as ornaments (e.g. Quiggin 1949, 52). This holds true for societies with formal, standardized exchange currencies and those that lack them.

Pendants, 'tinklers' and beads at and before the Contact Period

Contact Period Maya shell money was part of a currency system that also included cacao beans, greenstone beads, copper bells and cloth mantles (Fig. 10). All these currencies could be exchanged for each other or could purchase anything sold in the market, from Nicaragua to the Valley of Mexico (Blom 1932; Tozzer 1941, 95, n. 418). They could be used to pay porters a daily wage (100 cacao beans), as Blom (1932, 428) observes, or to pay fines imposed as a punishment (Tozzer 1941, 80, n. 342), or to buy oneself out of debt slavery (Tozzer 1941, 433). Cacao beans were counted in units of 1 (*Hun*), 20 (*Kal*, *Hunkal*, one score), 400 (*Bak*, *Bakal*), 8000 (*Pie*), and upwards in multiples of 20 (Blom 1932, 429; Tozzer 1941, 58, n. 279). These counts applied beyond monetary quantities to systems of reckoning numbers of canoes, warriors, or paces (Blom 1932, 429). These sources leave little question as to the general purposes for which these monies were used. Among the Contact Period Maya, jars of cacao beans were of equivalent value to strands of shell beads; 'coral-coloured' (red) shell beads were measured in hand spans, while other shells (perhaps white ones) were measured by the *braza*, or arm's length (182 cm)[1] according to the Relación de Valladolid (Rosado & Ontiveros 1938, 237–8). Examples of equivalencies between goods at Spanish Contact are listed in Table 1. This continuum of value for shell beads is similar to that of copper monies, in which axes were more valuable than bells.

Landa (1941, 96) lists monetary units of red shell beads or 'stones' (known as *kan*). Tozzer (1941, n. 418) adds green stone beads (*tun*)[2] and copper bells to the list of monies. Equivalencies were set within regions and currency exchange values were affected by availability (Blom 1932, 538). Price stability existed within regions like northern Yucatan with the exception of maize, according to Gaspar Antonio Chi, which cost more when it was scarce (Tozzer 1941, 231). Among the Aztec, money included cacao beans that were used as small change (Berdan *et al*. 2003, 102) while white cotton capes were of higher value (*quachtli*). Cotton mantles were also an important standard of exchange by which values were calculated at Spanish contact (Tozzer 1941, 96, n. 433) and presumably, earlier (Reents-Budet (2006, 117).

We suggest that Landa's bead money included a limited range of suspended or strung shell ornaments (Figs. 10–13). Objects that fit expectations for bead currencies include suspended *Spondylus*, *Strombus* and *Oliva* ornaments, along with cylindrical or discoidal beads made of *Spondylus*, *Strombus* or equivalents (Fig. 10). These objects are not only highly standardized through time, but they are widely distributed at different sites in the region, and are regularly found in contexts extending from the highest-ranking elites to humble commoners (Fig. 11). *Spondylus* pendants, usually one half of this bivalve suspended by two drill holes, were also imitated in white marine shell form. These bivalve pendants are found in all time periods. Also found are notched, perforated or spire-lobbed olive shells (Fig. 11) that are systematically recovered in Maya archaeology from the Preclassic through Postclassic at sites such as Colha, Cerros,

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Table 1. *Examples of currency units by container, length or count at Spanish contact.*

Material	Container	Length	Count	Source
Cacao	One jar (equivalent to one *braza* of white shell beads)			(Rosado & Ontiveros 1938, 237–8)
White shell beads Red shell beads	Sacks (sometimes)	*Braza* (a two arms' length strand of ~182 cm) *Palma* (hand-span strand of ~13.9 cm)		(Rosado & Ontiveros 1938, 237–8)
Cacao (and some shells?)	Sacks (sometimes)		1, 20, 400, 8000, 160,000	
Corn	One *fanega* of corn (equivalent to six Spanish *reales* or one *manta*)			(Tozzer 1941, n. 292, n. 427)
Cotton		One *manta* (folded cloth of 16 *varas*/12 m long and 3 *palmas*/41 cm wide) (equivalent to 1 *fanega* of corn or 6 *reales*)		(Tozzer 1941, n. 292, n. 427)

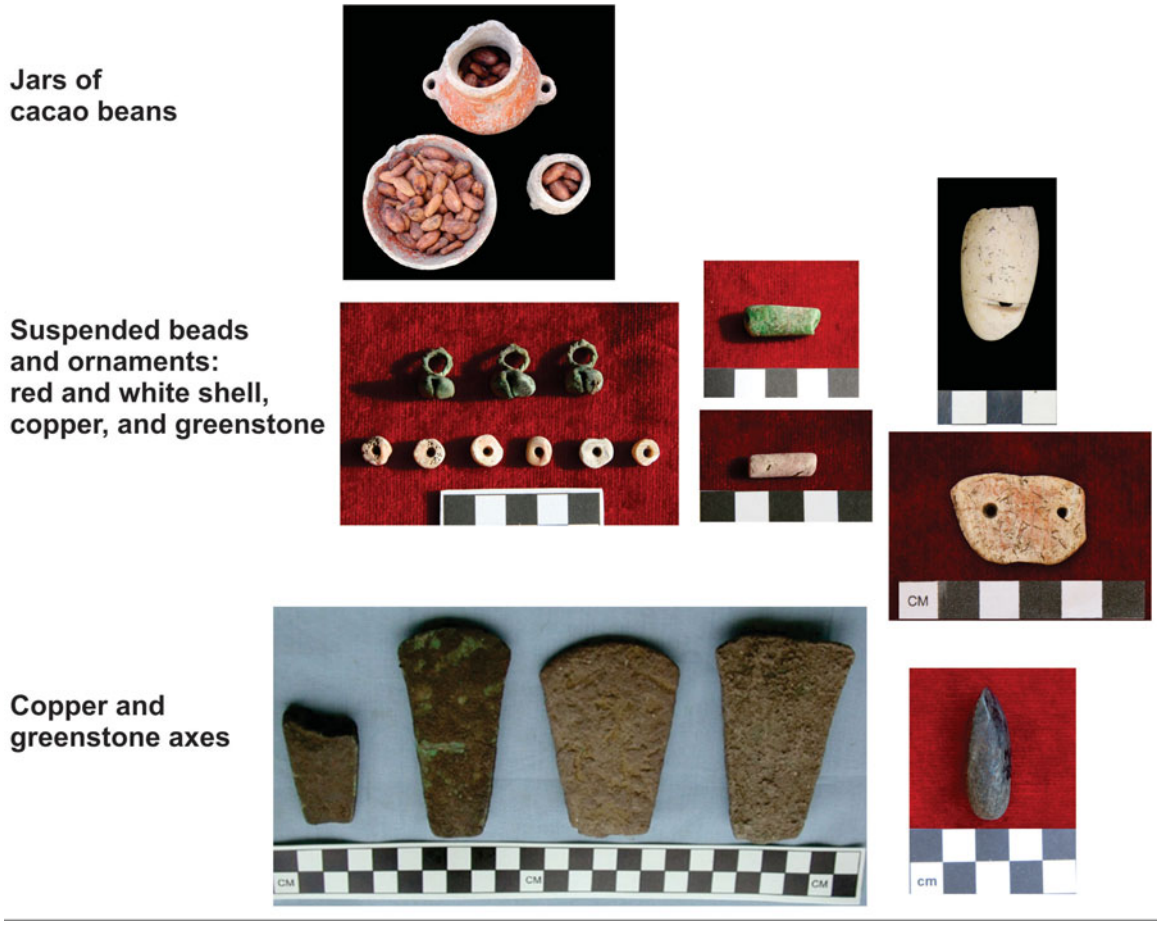

Figure 10. *(Colour online) Cacao, shell and jade beads and copper bells and axes were currencies in use in the Maya area at Spanish contact. Suspended ornaments and pendants of standardized form probably served as shell monies, along with beads. Unlike copper axes, it is not known if greenstone axes were used as currency. (Photograph of copper axes courtesy of Maxine Oland.)*

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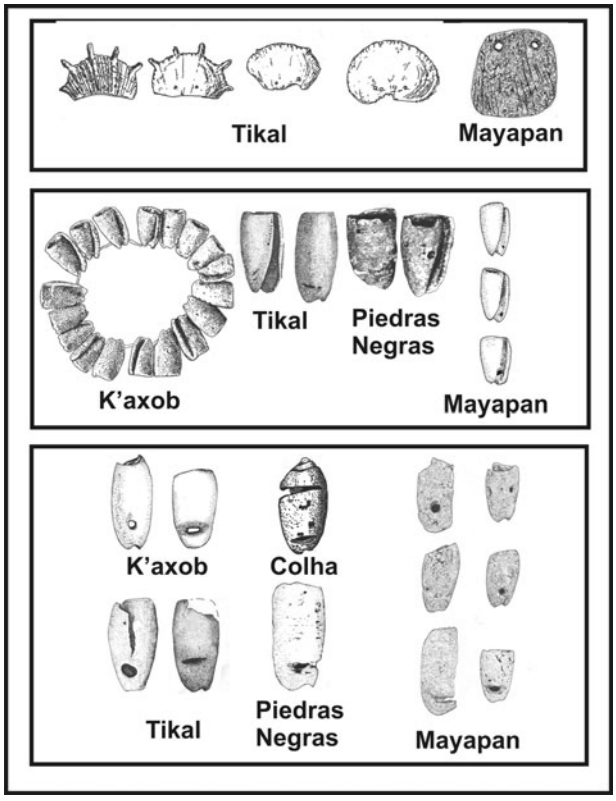

Figure. 11. *Long-term standardization in form for* Spondylus *and* Oliva *objects implies their use as monetary units. Examples here are from the Preclassic (Colha, K'axob), Classic (Tikal, Piedras Negras) and Postclassic (Mayapan) periods. (Illustrations by Kendra Farstad from reports on Tikal (Moholy-Nagy & Coe 2008, fig. 147 o, p, fig. 169 c, n), Piedras Negras (Coe 1959, fig. 52 s, t), K'axob (Aizpurúa 2004, fig. 14.9; Aizpurúa & McAnany 1999, fig. 2 j, m) and Colha (Buttles 1992, fig. 20).)*

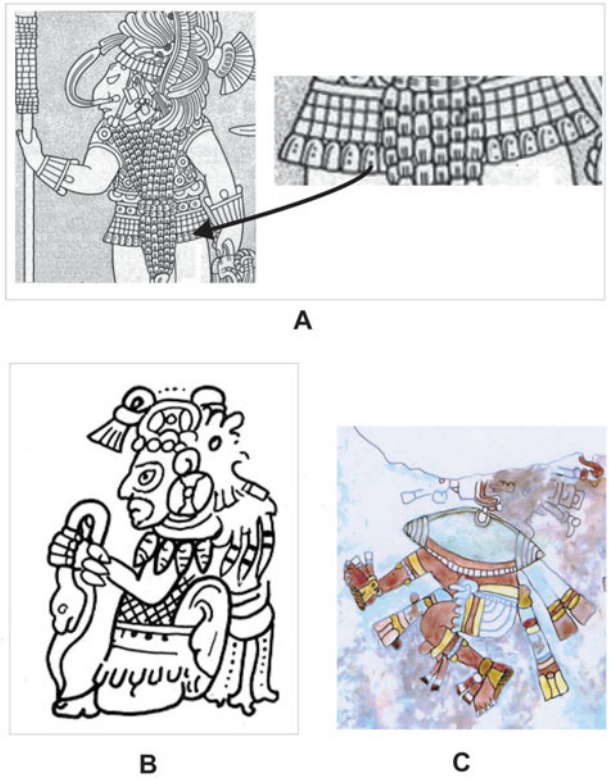

Figure 12. *(Colour online) Olive shells on kings and gods: (A) Yaxchilan (Schele & Freidel 1990, 286, fig. 7.8b); (B) Kukulcan (Taube 1992, 61, fig. 27a): (C) Pescador temple mural, Mayapán (courtesy Carlos Peraza Lope).*

Cuello, K'axob, Chan, Uaxactun, Piedras Negras, Altar de Sacrificios, Yula, Tikal and Mayapán (Aizpurúa & McAnany 1999, 122–3; Anderson 1998, 158; Buttles 1992, 102, 104–5; Coe 1959, fig. 52s, 5; Garber 1989, fig. 23; Hammond 1991a, fig. 8.46; Keller 2008, 10; Moholy-Nagy 2003a, 87; Willey 1972, 222, fig. 195). The notches and perforations may represent abbreviations of the mouth and eyes of fully carved death-head olive shells (Figs. 11, 13).

Like other standardized currencies of the ancient world, these *Oliva* shells for the Maya area were durable, portable, divisible and recognizable (Quiggin 1949, 322) due to their fairly constant size and weight and the fact that they are hard to counterfeit (Quiggin 1949, 26). Similar objects made from *Prunum* sp. or *Conus* sp. shells also substituted for olive shells. Certain perforated *Spondylus* pendants and beads also share these monetary qualities outlined by Quiggin. Like many money items in systems compared worldwide (Quiggin 1949, 322), *Spondylus* and olive shells were imbued with religious or magical properties, and they have great time depth in the Maya area (Figs. 11, 12; Freidel *et al.* 2002). Olive shells are given central importance in two major instances in Postclassic Maya iconography (Fig. 12); they form the collar of the deity and culture hero Kukulcan/Quetzalcoatl in the Dresden codex (Taube 1992, fig. 93), and a large pectoral olive shell graces the central figure of Mayapán's Pescador Temple mural, who is also perhaps Kukulcan (Masson & Peraza 2007). It is significant that Kukulcan/Quetzalcoatl, as an icon equated with statesmanship and wealth, regularly wears conspicuous shell ornaments.

Shell ornaments that decorated cloth or were draped over noble persons were also formalized currencies at Spanish contact (Blom 1932, 546). Landa (1941, 94–6) states that cacao and 'stone' (i.e. shell: Tozzer 1941, n. 418) beads were acquired through trade and that these 'jewels' were also worn by their

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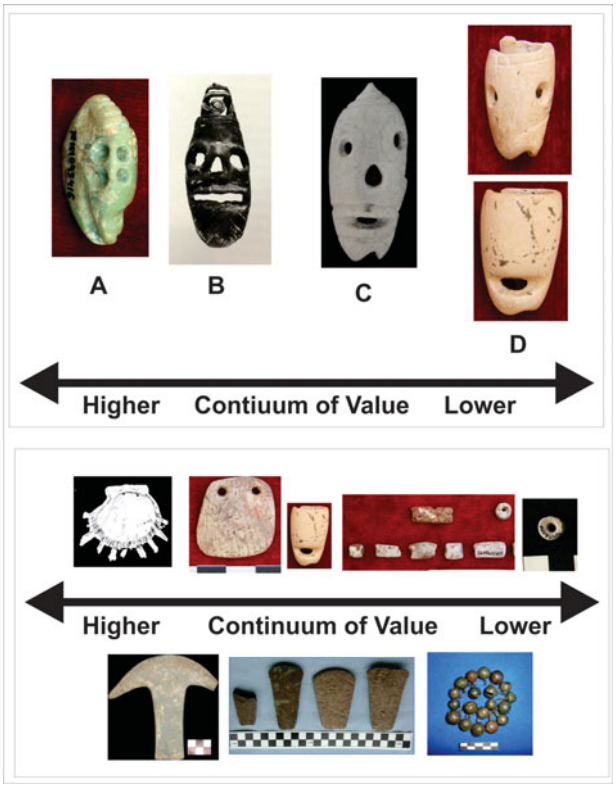

Figure 13. *(Colour online) Examples of continua of value within and between material or symbolic categories. Olive shells represented by (A) a jade bead from Mayapán, (B) a copper bell from Chichén Itzá (Coggins 1992, 122, fig. 139) and (C) a shell death-head from the Yucatan coast (Eaton 1978, fig. 32c). Simple perforations and notches may have been iconic (abbreviated) references of death-head versions (D). Continua of value were also expressed more broadly, for example, among shell and copper objects, as illustrated in the bottom half of this figure.*

'chiefs' 'in their feasts'. Contact-era Spanish chroniclers used the term 'bead' loosely to refer to suspended and strung shell objects, and other forms of suspended shells can also be considered as currency units. In fact, these sources paid so little attention to shell monies that they described them erroneously as 'stones' (Tozzer 1941, 95, 106, nn. 418, 488). The description of red 'stones' referred to ornaments that were monetary units, such as *Spondylus* chastity pendants; these pendants are also commonly presented as pectorals in Maya art (e.g. Tozzer 1941, 58, 80, nn. 270, 342). The equation of pendants and bead monies in Contact Period documents under the term 'red stone' opens the door for pendants to be grouped with beads in the array of shell currency. Bags of probable *Spondylus* pendants lie safely ensconced by a throne in the Bonampak murals, next to a bag of 40,000 cacao beans; such items represent tribute payments (Houston 1997; Miller 2013, 77–8; Stuart 2006). This association of bags of *Spondylus* next to bags of cacao is suggestive of currency status for both items. Stuart (2006, 150) concludes that such depictions of cacao are more than expressions of wealth and tribute, specifically, that they 'indicate a deep concern for the specific enumeration of the beans in the context of the royal court, where transactions and transfers of goods must have occurred with some frequency'. The status of *Spondylus* shells as payments in the Bonampak murals is also underscored by McAnany's interpretation that, elsewhere in the murals, richly attired messengers are walking tribute bundles bringing cotton mantles and the shells (both monies) to the site (McAnany 2010, 277; Miller 2013, 77).

Scarcity and renewability criteria

The currency argument is buttressed by the consistent recovery of olive or *Spondylus* shell forms even at sites where they could not be obtained from the nearest coast (Andrews 1969, 41, 43, 45). Olive and *Spondylus* shell objects may have assumed currency status precisely because of their relative scarcity. They are not abundant at most beaches of the Yucatan peninsula as are other shells,[3] yet they were clearly renewable resources. Olives are restricted to parts of the east and west coast of the peninsula, and even on the east coast at Cancun they form only 1.9 per cent of the total shell assemblage (Andrews 1969, 41; Andrews *et al.* 1975, table 2). *Prunum* is also restricted, and is procured mainly from the north coast of the peninsula (Andrews 1969, table 1). Einzig (1949, 441) critiques the view that money needs to be scarce, which is a relative circumstance related to the labour and risk needed to obtain it (see also Jones 1976, 775). A degree of scarcity is required (either real or created by taboos) but a steady supply must also be assured (Einzig 1949, 443). In short, we view red and white shell beads, tinklers and perforated (*Spondylus* or *Spondylus*-style) bivalve pendants as contenders for long-term currencies due to enduring similarities in form, and the fact that they are regularly recovered in archaeological contexts but are not overly abundant.

Spondylus and olive shells exhibit the lowest debris-to-finished-ornament ratios of all shell taxa at Mayapán (0.1), suggesting that a significant number of finished ornaments came into the site as monies and these items were not all made within the city, despite the presence of multiple shell workshops at this site (Masson & Peraza 2014, 335). In contrast, local shell-working industries for other shell taxa exhibit higher

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ratios, including *Strombus* (0.8) and various bivalves ranging from Pectinidae (0.9) to *Dinocardium* (23.7). At Tikal, olive and *Spondylus* shells also have the lowest ratios of debris-to-finished ornaments (0.04 and 0.002 respectively), compared to other shell taxa with ratios up to 39.8, for marine mussel (Moholy-Nagy 2008, appendix 5). Even at the small Classic Period centre of Chan, Central Group village leaders worked *Strombus*, but central burials had olive tinklers and *Spondylus* ornaments that were not made locally and were gained through exchange (Keller 2008, 10). Olive-shell tinklers were also widely distributed at nearby San Lorenzo (Yaeger & Robin 2004, 156). A low incidence of *Spondylus* shell working is also reported for Caracol (Chase & Chase 2004, 119). Marine shell working in general was low at Altar de Sacrificios, a site that imported most of its finished shell objects (Willey 1972, 220). Shell currencies should frequently enter a site in complete form and local production should not fully account for their presence. The patterns described above meet this expectation.

Lengths, weights and other measures

Olive-shell ornaments were suspended in strand lengths and on belts in a manner that might be expected for currency items (Figs. 11, 12). In the Maya area, Reents-Budet (2006, 121) notes that *Spondylus* shells often adorned capes of courtly officials and deities; olive shells are also seen in Maya art adorning kings and gods (Fig. 12). Olive shells are similar to *Spondylus* in their longevity in the Maya archaeological record, and also by the fact that they adorned royal clothing (Fig. 12) and were common burial offerings. Olive tinklers are present in monumental art from Caracol, Copan, Quirigua, Seibal, Tikal, and Yaxchilan (Fig. 12; Aizpurúa & McAnany 1999, 119; Buttles 1992, 104; Coe 1959, 58).

Shell valuables used by peoples in the Colonial world were commonly measured in lengths, often recorded as a fathom in many Euro–indigenous encounters across the world (6 ft/183 cm). The *braza* in the Colonial world actually varied in its length, as short as 167 cm in Spain but longer in parts of Latin America (Rowlett 2000). More valuable red beads (we infer to be *Spondylus*) were measured according to one hand-span[4] (or *jeme* 5.48 inches, 13.9 cm) according to the Relación of Valladolid (Rosado & Ontiveros 1938, 237–8). Hand-spans could refer to lengths as great as 20 cm, a 'palmo' in Spain (Rowlett 2000). Clearly, shell beads of different types had different value, and were strung together in varying lengths according to this value. References to weights (Humberto Ruz 1988, 74) and measures in the Contact Period suggest that strand lengths, containers and counts were important, perhaps overriding minor differences in actual object size of shell objects or cacao beans. Woven cloth of different lengths and quality served as a standard of exchange (Blom 1932, 541; Landa 1941; Piña Chan 1978, 48; Tozzer 1941, n. 418[5]) and metal bells may have had values according to size (Tozzer 1941, 23, n. 418). Shell money units elsewhere were sometimes limited by size constraints (Quiggin 1949, 297, 305). Clearly, *Spondylus* was the most valued of shells utilized in ancient Maya economic systems as they are the most difficult to acquire of regularly desired marine shells and are found in the richest contexts at Maya sites (Moholy-Nagy 1963, 80). At the Mayapán Itzmal Ch'en temple, an olive-shell effigy made of jade (Fig. 13a) was found that seems to embody, on a symbolic level, the concept of currency interchangeability. Similarly, copper effigies of olive death-heads were found in the sacred cenote at Chichén Itzá (Fig. 13b; Coggins 1992, 122, fig 139). Twenty shell effigies of cacao beans were found in a bowl accompanying a tomb at Ek Balam, which would have served as 'incorrigible cash for the afterlife' (Miller & Martin 2004, 86, pl. 37).

Measurements recorded at Contact probably drifted in their specifications through time. Continued research on this topic might amass a sample of measurements of full sets of strung shell objects found in the archaeological record. For example, two sets of *Spondylus* discoidal bead strands were bound together, abacus style, by bone clasps at Tikal (Moholy-Nagy & Coe 2008, fig. 155, 1b, 1c). These were found in burials. One set has 14 strands that hold together 840 beads. The length of each strand (~14 cm) is generally equivalent to one hand-span (13.9 cm) during the Contact Period. The total length of all 14 strands is 195 cm (as estimated from the photograph), longer than the Contact-era *braza* of 183 cm. Perhaps *braza* lengths were not used for *Spondylus* beads. Shell size may have also figured into complexities of measurement. Larger *Spondylus* beads were strung in a second set of seven strands at Tikal, which had a total of 180 beads. The individual strand length of this set (12.7 cm) fell short of the Colonial hand-span length of 13.9 cm, which suggests that strand lengths varied according to bead size, or that the Tikal strands are quite unrelated to the Colonial measurements. It is perhaps significant that the first set of 14 strands has exactly twice the number of strands as the second set of seven strands. Finally, it may be worth noting that the total number of beads in each set of strands (840, 180) is divisible by 20. Further work is needed to measure strand lengths of different kinds of shell.

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Diachronic variation and continuity in potential Maya shell monies

The importance of specific shell monies would have varied over time, as suggested by comparisons of Tikal and Mayapán (France 2008; Masson & Freidel 2012, 471; Moholy-Nagy 1963; 2003a,b; 2008; Moholy-Nagy & Coe 2008). *Spondylus* was more important at Tikal (comprising 66 per cent of the marine shell, *versus* 1 per cent at Mayapán). At Mayapán, *Strombus* was more important (34 per cent versus 1–4 per cent at Tikal). Olive shells (and similar species) were present in equivalent proportions at both sites (4 per cent). *Spondylus* beads were singularly important in Late Preclassic contexts at Tikal, but in the Classic Period, shell industries (including *Spondylus*) became more diversified and the use of other species proliferated for a variety of purposes (Moholy-Nagy 2008; Masson & Freidel 2012, 471). Finished objects form a smaller proportion of the assemblages of both sites (e.g. Moholy-Nagy 2008, appendix 5). Of the finished shell objects, candidates for currency exhibited roughly equivalent proportions at both sites: discoidal or cylindrical beads formed 13–14 per cent for Tikal and Mayapán respectively and olive tinklers formed 4 per cent of each site's finished objects (Masson & Freidel 2012, 471). Only pendants differed, forming 2 per cent of Tikal's finished shell artefacts and 30 per cent of Mayapán's. Collectively, beads, tinklers and pendants form only 18.3 per cent of the finished shell sample from Tikal, as opposed to 81 per cent of the Mayapán sample. If these objects served as currencies, they became more popular through time. For both Tikal and Cuello, sites of contrastively different sizes, beads formed the majority of finished shell objects in the Late Preclassic Period (Hammond 1991a, 183–5; Moholy-Nagy 2008).

Unlike either Classic Tikal or Mayapán, the Late Preclassic Tikal assemblage was far more restricted in variety as 99 per cent of all of the shell recovered for this period consists of *Spondylus* beads and these form 98 per cent of the finished shell object sample. Freidel *et al.* (2002, 43) discuss the Late Preclassic significance of *Spondylus* beads to the development of currencies. Similarly, beads formed the majority (97 per cent) of Preclassic shell artefacts at Cuello (Hammond 1991a, 183–5), and in this sample, *Spondylus* beads and spire-lopped olive shells are present in low frequencies. As beads are recovered from general as well as mortuary contexts, Hammond (1991a, 187) suggests they were a commonly desired (and obtained) commodity, if in low numbers. He also notes that Maya shell working was conservative and shares similarities across time and space (Hammond 1991a, 187). Hammond identified some of the characteristics we view as diagnostic for shell monies. These comparisons reveal that certain shell taxa and shell object forms within each time period seem to have been more valuable, more standardized, and they were made and circulated differently from other more idiosyncratic, variable approaches to modifying other shell taxa. Despite this variability, *Spondylus* was always important, as were shell beads, with olive tinklers and bivalve pendants (including *Spondylus*) exhibiting more importance in the Classic and Postclassic era.

The shell forms that we have highlighted as potential currencies, like all Maya artefacts, can be classified along a continuum of quality (of workmanship) and value (e.g. Fig. 13e). Greenstone is probably the most poorly understood of the candidates for currency, probably because so many non-currency exquisite objects were made of jade in Maya history. Yet Tozzer argues (1941, 95, n. 418) that greenstone beads were monetary at Spanish contact and metal axes are also said to have served a monetary function. Next, we consider greenstone objects, including beads and axes, as they might have been perceived, along a symbolically laden inalienable-to-alienable continuum (Fig. 13).

Greenstone

Dichotomous schemes of valuable/non-valuable, elite/non-elite, ceremonial/utilitarian do not do justice to the continuum of quality on which many objects can conceptually be placed (Lesure 1999, 24). Definitions of valuables arise from historical contexts, and, in the Maya case, from agrarian life as for the symbolic relationship between maize and greenstone celts (Freidel & Reilly 2010). Co-opting the agricultural celt in kingly regalia was part of a larger process of incorporation and exaltation of initial Formative village traditions, including the calendar (e.g. McAnany 1995, 162–5). Gradations of value in greenstone celts existed from early in the history of Mesoamerican settled village life (Lesure 1999, 45). Degrees of alienability can be tracked in artefacts and their contexts and exchange patterns are not exclusively horizontal or vertical (Lesure 1999, 25–6). In the comparative case of Maori greenstone marshalled by Lesure, inalienable, unique objects include special weapons or elaborate pendants, but similar objects of different quality and texture were alienable (Lesure 1999, 34). He draws analogies to broadly distributed metamorphic greenstone celts at Paso de la Amada, Chiapas, Mexico. These celts are highly similar to those recovered widely throughout subsequent periods, including at Mayapán.

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Gradations of value have long been recognized for Maya greenstone objects from the Formative Period (e.g. Hammond 1991b, 244) as well as the Classic Period (e.g. Coe 1959, fig. 44).

Recently, David Stuart (2006, 150) proposes that 'the use of chocolate as a primitive money with commercial uses may have existed before the Post-Classic period', based on evidence of counted bundles (*pik*, a unit of 8000 beans) in the hieroglyphic record, and analogies to central Mexico. In contrast, he proposes that jade objects were personal property and were reserved for tribute, gifts or cargo/burdens. According to Stuart, cacao beans lend themselves to standardization to a greater extent than jade objects. In the Contact period, jade plaques were distinguished from jade beads of the sort used for currency. This suggests a treasure-currency continuum, as we have argued above. We do not doubt that carved jades were precious treasure and it is quite certain that important royal regalia were fashioned of jade and other greenstones. Such observations, however, do not belie the prospect that more anonymous jade artefacts, such as beads, and conventionalized small pendants, served as currency in the Classic period as in the Postclassic. We agree that finely made, idiosyncratic jade ornaments were likely personal possessions (Stuart 2006; Taube 2004), but is it possible that early greenstone axes, which varied in quality from fine jade celts to ordinary serpentine axes and chisels, were utilized as currencies as were metal axes in the Contact Period (Freidel & Reilly 2010; Hosler 2003)? Cloth and thread also varied in quality and value at this time (Clark & Houston 1998, 37). We think that more common jade beads and greenstone axes were currency units, although a lack of standardization causes Taube (2004) to doubt the status of early celts as true monies. Freidel and Reilly (2010) build on Taube's discussion of these items as potential currencies, and note that our expectations of standardization might not match those of the past. They observe that in Mesoamerica, counting commodities was generally emphasized over weighing them, and hence standardization of jades may not have been as important as elsewhere in the ancient world.

Greenstone axes exhibit regular distributions in Classic Period commoner houselots (Sheets 2000, 228), and serpentine varieties are reported as early as the Late Preclassic from Colha (Buttles 1992, 135) and Tikal (Moholy-Nagy 2003a, 86), and also from the Middle Preclassic onward at Altar de Sacrificios (Willey 1972, 132), Late Preclassic Cerros (Garber 1989) and Seibal (Willey 1978). Other sites with these objects from Preclassic or Classic Periods include Piedras Negras, Palenque, Uaxactun, Tikal, Benque Viejo, Copan, Baking Pot, Lubaantun, Actun Balam, Quiroz Cave, the Middle Motagua region (Willey 1972, 132), and while Willey notes that they are more common in the Classic Period (1972, 133), these objects also remained important at Mayapán. They commonly exhibit use wear (e.g. Willey 1972, 132). Willey (1972, 132) distinguishes four size grades ranging from very small (2.9–5.2 cm long) to large (>15 cm). The entanglement of jade/greenstone and shell in the realms of symbolic, prestigious and tangible, practical value are described in detail by Freidel *et al*. (2002). Yet greenstone and shell were not monolithic material categories. It is too simplistic to focus solely on the most exquisite, unique examples which were probably inalienable (Rice 2009, 77). Rather, they should be viewed as part of a system of objects that fell into the hands of many members of society. The 'imbued social meaning' and 'ritually charged' aspects of the finest examples (Rice 2009, 77) also conferred value to their simpler, parallel counterparts.

Discussion

Metaphorical and symbolic links between maize and jade, or certain shells and cosmology, were not epiphenomenal, but were linked to real world capacities in the context of economic systems that included the essentials of daily life. Freidel and colleagues (Freidel *et al.* 2002; Freidel & Reilly 2010) lay out the links of jade, maize, the maize god and rulers and *Spondylus* shell in an embedded system of classification defining a continuum of treasure-regalia and currencies. We have attempted here to advance the argument by considering the practical, artefactual nature of accounting and large number calculation, and the identification of calculating tokens as part of this continuum in the case of such materials as precious stone and shell. Olive shells were part of this continuum in our view and likewise bore a symbolic load; Thompson (1950, 138) pointed out that their glyphic and iconographic association with completion and death, which Coe (1959, 58) suggests may explain their common inclusion in mortuary assemblages. The use of olive to signal 'zero' in the positional notation of large numbers is *prima facie* evidence of its use as a calculating token along with 'sticks and stones' of other materials.

The consideration of valuables as currencies potentially represents a material bridge for the dichotomous models of Maya economy. We highlight two findings that compromise the redistribution and dual economy models (as recently described by Scarborough & Valdez 2009; Stark & Garraty 2010, 36, 48). First, valued items do in fact exhibit wide

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distribution across social status lines in the Classic Maya realm (Masson & Freidel 2012; 2013), beyond quantities expected for 'escaped' (Smith 1999; Stark & Garraty 2010, 36) precious goods trickling down the social ladder. Differences between elites and commoners can easily be explained by wealth disparities and relative buying power. A few exquisite goods are constrained to elite circulation as in most societies, such as gold, turquoise, or jaguar skins in the Aztec realm (Blanton *et al.* 2005, 273; Smith 2003, 123). Second, many finely crafted goods are replicated by simpler iterations that are widely circulated. An inalienable-to-alienable continuum can be tracked for cloth, metals and certain shell objects in the Maya currency system during the Contact Period and, we argue, from the Late Preclassic forward (Figs. 11, 13).

A robust consideration of the kinds of currencies with antiquity in the Maya area should include an entire system of monies of different media as well as gradations in quality and value within specific media. Garraty (2010, 6) defines markets as institutions based on the commercial exchange of alienable commodities. Recognizing a continuum of valuables will not only assist the field of Maya archaeology in distinguishing potential currency units in common use, but will also touch on deeper issues of how elite manipulation and use of elaborate effigies of these currencies—as well as effigy tokens of goods—contributed directly to the construction and maintenance of commodity value systems with commercial applications. Pursuing the analysis of items that potentially represent forms of currency in use over the long term in the Maya area contributes additional data to a model of earlier Maya market systems.

It is important to consider how commercial exchanges as well as the business of tribute might have been recorded and tabulated in administrative circles of royal Maya courts. To date, most studies have focused on tribute encounters as depicted on the painted vases of the Classic Maya, but as we have hoped to demonstrate, there is a great deal more that can be discerned in these scenes relevant to accounting of the kind that would have been necessary for trade administration as well as tribute. We add the artefact categories of calculating tokens and sticks, and such recording devices as styluses and writing boards, to the objects to look for both in artistic depictions and in the archaeological record as ways to pursue the matter of economic administration. In the case of calculating tokens, we have proposed that some of these items are made of materials, shell and stone among them, that also occur as monies and regalia that were treasure and possibly inalienable. Shell cacao beans, miniature spindle whorls, *Spondylus* and jade spangles, olive-shell effigies in jade, *Spondylus* and copper, are well contextualized artefacts, in our view, that provide clues to the cross-correlation of such conceptual categories. The courtly Maya of the Classic period, we suggest, were quite comparable to their Postclassic counterparts in their interests and involvement in exchange, commerce and accounting, and the challenge is to initiate sustained and critical inquiry into Classic Maya business activities. We think that, just as the time has passed to regard Maya high elite as unconcerned with such state matters as war and diplomacy, so it has also passed to regard such elite as parasites merely exacting tribute from their vassals and citizens.

Notes

1. A *braza* was equivalent to two Spanish '*vara*', which was also equivalent to one Maya '*zap*' (or two Maya '*betán*' units of 91 cm each). Tozzer (1941, 58, n. 279) describes one 'arm's length' of red beads and one 'score' of green stones distributed in a treaty at Maní in 1557.
2. Tozzer credits Scholes and Roys (1938, 612).
3. Cowrie shells were also not widely available elsewhere in the ancient world, but were supplied to parts of the Indo-Pacific region from the Maldive and Laccadive islands at certain points in time.
4. Quiggin (1949, 295) describes methods for measuring single or strands of shells using creases in the hand; tattoos were utilized by persons of different sizes to be able to measure accepted standards among the Yurok.
5. Tozzer cites Cogolludo (1688, 4, III).

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