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Unwinding the Rubber Ball: The Glyphic Expression *nahb'* as a Numeral Classifier for "Handspan"

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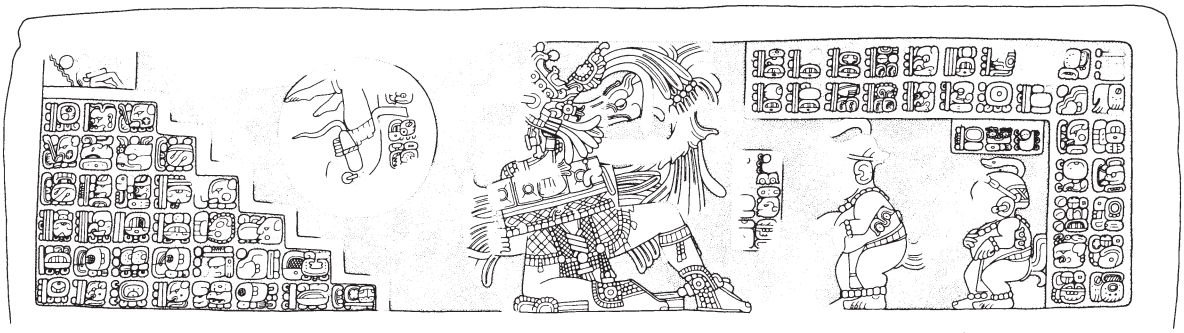
The rubber ball is one of the essential implements of the Mesoamerican ballgame. Recent investigations have elucidated the prehispanic production of rubber balls (Hosler, Burkett, and Tarkanian 1999) and its iconographic significance (Stone 2002). To these, we would like to add the textual analysis of inscribed rubber balls in Maya art (see also Zender 2004). They occur on a number of murals, stone monuments, and polychrome vessels that not only show the ball (usually but not exclusively in ballgame scenes), but also refer to it either in the accompanying text or by glyphs that are directly inscribed on it. The majority of texts consists of the numbered *nahb'* expressions that we interpret as "*X* handspans" and that likely refer to the dimensions of the rubber ball (Figure 6). Previous interpretations of the rubber ball have focused on its symbolic and metaphysical aspects (e.g., the ball as the sun traveling into the underworld). The numbered *nahb'* expressions imply a more utilitarian interpretation. We propose that the numbered *nahb'* expressions refer to the length of the rubber strip that makes up the rubber ball. They provide in this way a measurement for the size of the rubber ball.

THE BALLGAME AND INSCRIBED RUBBER BALLS IN MAYA ART

The ballgame represents one of the principal genres of Maya art, and it occurs in a variety of formats. Representations on stone monuments tend to focus on the ruler as the principal ballplayer (Figure 1). They regularly exclude such important components of the ballgame as co-players or the other team to the point where only single elements—for example, the paraphernalia worn by the ruler on Panel 2 from La Amelia—remain to suggest it. Polychrome vessels, on the other hand, go beyond the ballplaying noble and prefer full-fledged, multi-figure ballgame scenes (Figure 2). The participants of both sides are shown in action, and bystanders, decorations or architectural details add atmosphere. Non-sports-related motifs often supplement the ballgame scenes: dwarves that hint at the underworld populate the ballcourt, or captives that are tied into a ball meet their sacrificial death (Figure 1). Glyphic texts can frame the scenes by adding dates, specific events, and names of actors, and they seemingly even preserve comments on the game (e.g. on K5435 in Kerr 1997 [V]:798).

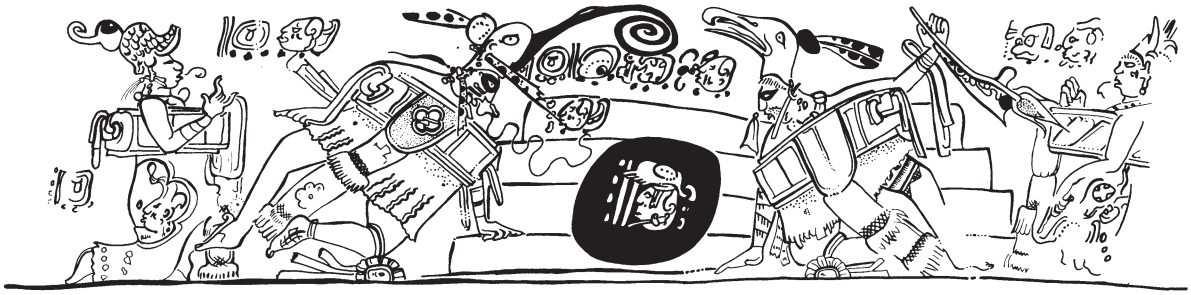
The rubber ball represents a quite natural but not exclusive part of ballgame scenes. The plain and undistinguished ball is in a surprising number of cases replaced by ornamented or glyphically inscribed variants. Table 1 adds significantly to the thirteen examples that were

FIGURE 1: THE BALLPLAYING SCENE ON STEP VII FROM YAXCHILAN'S HIEROGLYPHIC STAIRWAY 2.



(AFTER GRAHAM 1982:160)

FIGURE 2: THE BALLGAME SCENE ON VESSEL K2912.

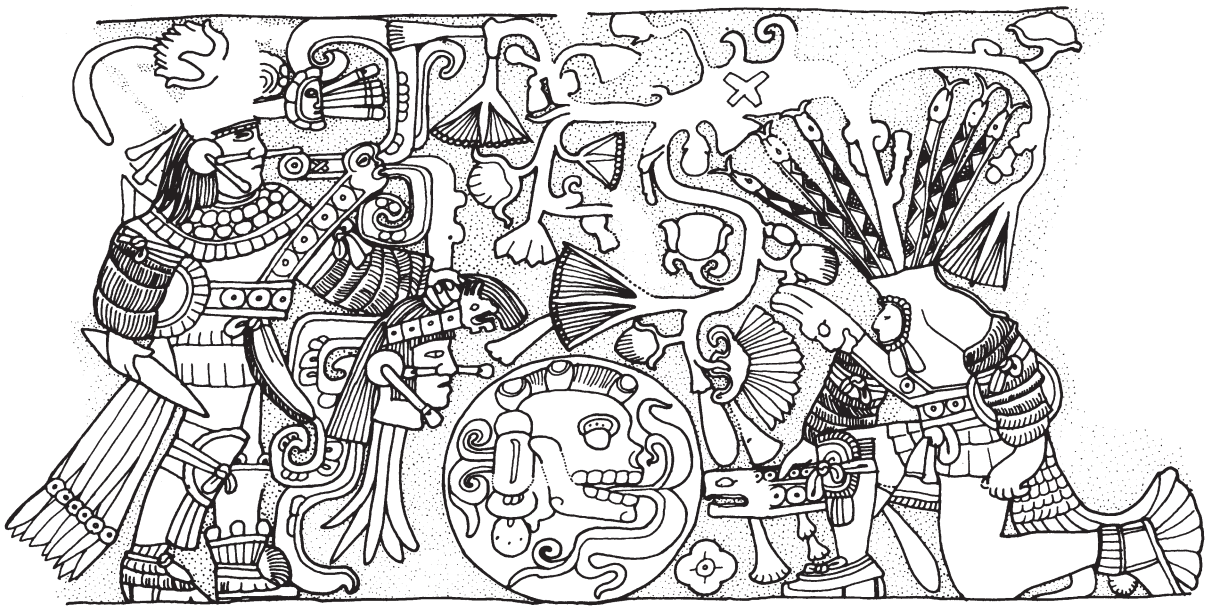


(DRAWING BY M. EBERL AFTER SCHELE AND MILLER 1986:255)

previously known (Boot 1991:237–242) and lists 52 occurrences of inscribed balls. The great majority—34 cases—mention the glyph collocation *nahb'* that is further discussed below. Many of the remaining rubber ball representations contain either a skull, especially at Chichen Itza (Figure 3), or a tied captive who is curled down a stairway, as on various steps of Hieroglyphic Stairway 2 from Yaxchilan (Figure 1).[1]

Six unique examples remain. The ballcourt marker from La Esperanza (formerly attributed to Chinkultic) depicts a head inside the rubber ball (Navarrete 1984:fig. 88; Figure 4a). This head has been interpreted as the head of Jun Ajaw, one of the Hero Twins (Kowalski 1989; for an interpretation as the head of God N see Cohodas 1991:260). Another head on the ball in the ballgame scene on Monument 2 from Ichmul de Morley refers to a supernatural patron of the ballgame whose name includes the number seven (see Figure 10, glyph B). Scholars identified it as Old Deer God (Hellmuth 1991), *Wuk Si'p* "Seven Sip" (Tokovinine 2002) or *Huk(te') Ajaw* "Seven Ajaw" (Zender 2004). The ballgame mural in Tikal's Group 6C-XVI Sub-21 contains a ball with an as yet unidentified head (Figure 4b). The center marker from Copan's ballcourt II-B shows a ballgame scene with an inscribed ball (Figure 5a). The

FIGURE 3: THE CENTRAL SCENE FROM THE RELIEF OF CHICHEN ITZA'S GREAT BALLCOURT.



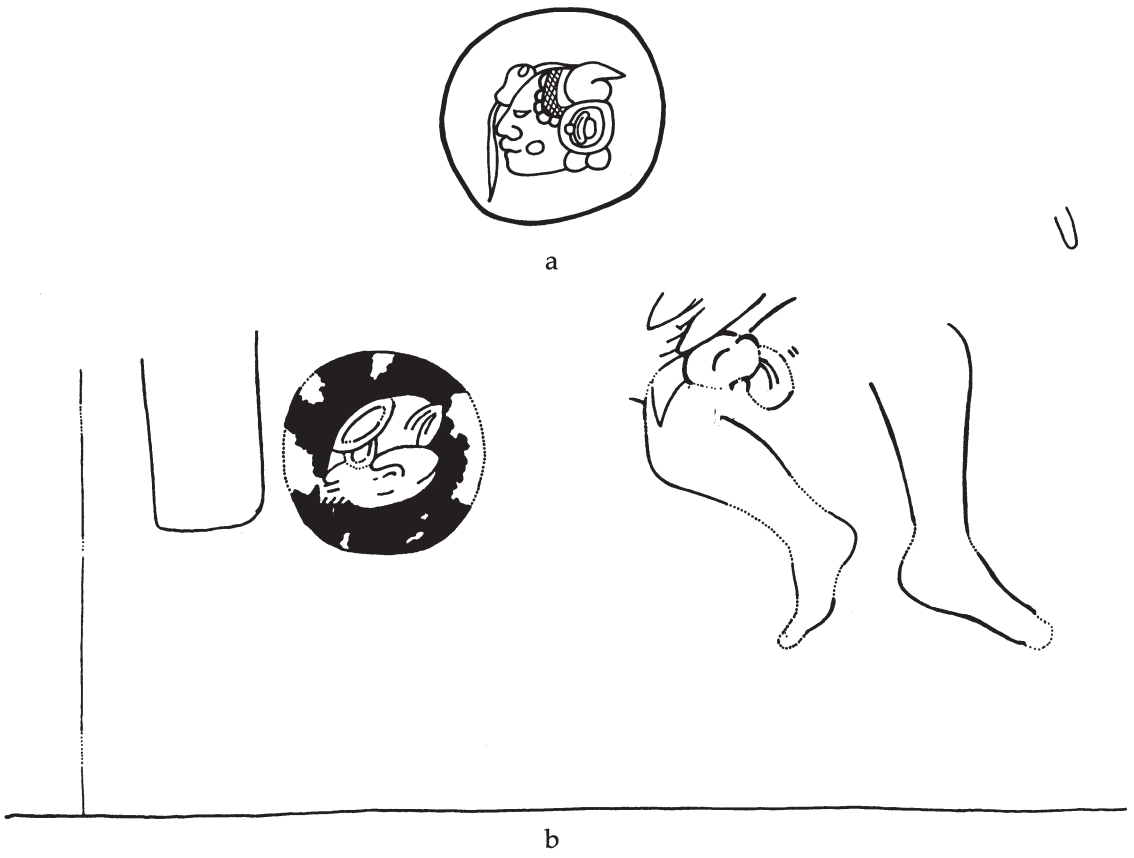
(AFTER SCHELE AND MILLER 1986:244)

glyphs have been interpreted as *k'an tuun* "yellow, precious stone" (Stuart 1990:13) or *k'a[h]n tuun* "pedestal/flat stone" (Lacadena and Wichmann in press) and as a reference to the marker itself. The ball on Stela 4 from Itzimte is possibly marked with "2 Ajaw." This is presumably the erection date of the monument (Graña-Behrens 2002:29*f.*, 301). Mucaancah, a site in southeastern Campeche, has two ballplayer panels (Šprajc, García Cruz, and Ojeda Mas 1997). The ball on the less eroded Ballplayer Sculpture 2 shows a rubber ball with a possible T4 **na/NAH** subfix (Figure 5b).

INTERPRETATIONS OF THE INSCRIBED RUBBER BALLS

The most common current interpretation stresses the association of the numbered *nahb'* expressions with the underworld. It is partly based on numerology, that is, the idea that "[i]n Maya iconography, specific numbers may function as shorthand symbols for cosmographic relationships" (Cohodas 1991:274). The number nine (*b'olon*) that seemingly prevails on inscribed rubber balls evokes the Nine Lords of the Night, Bolon Okte, the nine layers of

FIGURE 4: HEADS ON RUBBER BALLS.



a: DETAIL OF THE LA ESPERANZA BALLCOURT MARKER (DRAWING OF L. SCHELE AT ‹HTTP://FAMSI.FAMSI.ORG/DATASPARK/SCHELE/HIRES/10/IMG0070.JPG›, REDRAWN BY M. EBERL).
b: BALLGAME MURAL FROM TIKAL GROUP 6C-XVI SUB-21 (AFTER LAPORTE AND FIALKO 1990:54, FIG. 3.18).

the underworld, etc. All of these deities and concepts relate to darkness and the underworld and bespeak a corresponding symbolism of the number 9 (see also Ashmore 1991:201; Coggins 1988:69; Stone 1995:150–151; Thompson 1970:195). The **na-b'a** glyphs that follow the number (Figure 6) have intrigued scholars because many dictionary entries translate *nab'* as "ocean, standing water, water lily, etc." (Stuart and Houston 1994:69; Boot 1991:239). Several studies contend that the Maya perceived the underworld as a watery place (Hellmuth 1987b) and further argued that the ballcourt opened into the underworld (Ashmore 1989:279; Freidel, Schele, and Parker 1993:350–355; Gillespie 1991:341; Kowalski and Fash 1991; Schele and Freidel 1991). The translation of *nab'* as "ocean" became at least for some scholars reasonable when taken as a reference to the waters of the underworld.

The second interpretation of the numbered *nahb'* expression is based on the connection between the ballgame and sacrifice. Linda Schele and Mary Ellen Miller (1986:255) suggest: "The rubber balls used by the Maya often appear inscribed with the numbers 9, 12, 13, or 14 *na:ab*. Their meaning is not known but the coefficient could refer to the number of human sacrifices at stake." They provide no specific evidence for this hypothesis. Other scholars, how-

FIGURE 5: OTHER GLYPHS ON RUBBER BALLS.

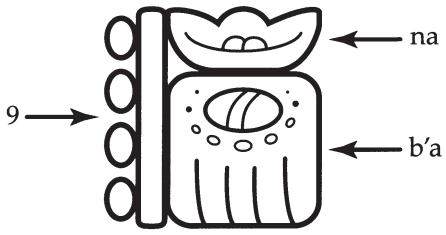
a

b

a: Copán Center Marker of Ballcourt II-B (drawing by Barbara Fash in Schele and Miller 1986:257 Plate 102a).

b: detail of Mucaancah Ballplayer Sculpture 2 (drawing by M. Eberl after unpublished photos of Jack Sulak).

FIGURE 6: THE SCHEMATIC *NAHB'* EXPRESSION.



(COMPUTERIZED DRAWING BY M. EBERL)

ever, have pointed out that several steps of Hieroglyphic Stairway 2 at Yaxchilan depict balls in the form of captives who are rolled down a stairway (Figure 1; A. Chase, Grube, and D. Chase 1991:11; Schele and Grube 1990) and that the skulls inside the balls on ballgame panels at Chichen Itza are a wordplay for "captive" (Krochock and Freidel 1994:365). These examples indicate that human sacrifices were part of a ritual form of the ballgame. However, only six of 52 carved rubber balls (11.5%) show captives or skulls (Table 1). To extrapolate from these examples to all inscribed rubber balls seems, therefore, unwarranted. It also leaves the *nahb'* part unexplained.

The third interpretation of the numbered *nahb'* expressions is that they represented the score of the ballgame (Boot 1991:237; Grube and Nahm 1994:711; Schele and Miller 1986:254 note 22). As with the preceding interpretation, it remains unclear to what *nahb'* may refer. It has also been noted that "a true score requires two numbers" and not one (Schele and Miller 1986:254 note 22).

The cautious statement of Miller and Houston (1987:60 note 27) summarizes the interpretations that have been advanced so far: "On both pots and sculpture, balls are commonly inscribed with the numbers 9, 12, 13, or 14 and a glyph to be read as *nab* or *na:ab*. *Na:ab* is generally understood to mean "water lily" or "standing water", but to date no sense can be made of the glyph in the context of the ballgame."

INSCRIBED RUBBER BALLS: DISCUSSION OF THE GLYPHS

The great majority of inscribed rubber balls feature a number that is followed by glyphs (Table 1; Figure 6 exemplifies the expression). The number is generally written in the bar-and-dot system (the only exception is a head variant on polychrome vessel K3842; Table 2). The number 9 is frequent but is not the only number on inscribed rubber balls. It occurs in 15 out of 34 legible examples, followed by the number 12 (11 out of 34). The range of numbers is also greater than previously thought and extends from 7 to 14 (the only unattested number is 8).

The glyphs that follow the number are graphically more variable, but are read in most cases as *nahb'*. The purely phonetic spelling T23:501a **na:b'a** occurs seven times (Table 1; Figure 7).[2] Yuri Knorozov (1967:79, grapheme 029) established the reading of T23 as **na** (see also Lounsbury 1984), and David Kelley (1976:185) the reading of T501a as **b'a**.[3] Common

TABLE 1: GLYPHS ON RUBBER BALLS (LIST OF THE AUTHORS).

Inscription	Text	Reference
7 *nahb'*		
Lubaantun Ballcourt Marker III	VII.?:501a	Wanyerka 2003:Fig. 5
9 *nahb'*		
Calakmul Stela 66	IX:220var?:?.528:116	Marcus 1987:35
La Amelia Panel 2, glyph A5b	IX.23:501a	Houston 1993:87
La Amelia Hieroglyphic Stairway 1, Step 4, glyph pC2	IX.23:501a	Mayer 1991 [VI]:plate 4; Schele and Grube 1995:173
Site Q Ballplayer Panel 6	IX.23?:501a$_{HV}$:142var	Schele and Miller 1986:258
Yaxchilan Hieroglyphic Stairway 2, Step IV	IX.?:501a/b?	Graham 1982:157
K2911 (small bottle)	IX.23?:501a	Schele and Miller 1986:264
K3842	IX$_{HV}$.220var:501a	Kerr 1992 [III]:442
K4684[a]	IX.217:501a	Kerr 1994 [IV]:589
K4925	IX?.220var?:501a?	Kerr 1994 [IV]:613 bottom
K5206	IX.220var:501a/b?	Photo in J. Kerr's online database (‹www.mayavase.com›)
Chocholá style vessel ("Ballplayer I")	IX.220var:501a	Tate 1985:130 Fig. 12
Chocholá style vessel ("Ballplayer III")	IX.?:501a?	Tate 1985:130 Fig. 14
9 BALL		
Caracol Altar 22	IX:BALL	A. Chase, Grube, and D. Chase 1991:12
Naj Tunich Drawing 21	IX:BALL	Stone 1995:150
PNK Stone monument (Estación Mojarras or Tonalá?)[b]	IX?:BALL	Mayer 1991 [VI]: plate 227, Cat. No. 113
10 *nahb'*		
Cancuen Ballcourt Marker 3 K635, glyph I'5	X?.220var:501a X.217var:501a	Personal observation of the authors Coe 1973:103
11 *nahb'*		
Cancuen Ballcourt Marker 2	XI.220var:501a	Demarest and Barrientos 2004:487
12 *nahb'*		
Cancuen Ballcourt Marker 1	XII?.220var?:501a?	Greene, Rands, and Graham 1972:211
Site Q Ballplayer Panel 2	XII.23var:501a$_{HV}$	Mayer 1995 [VII]: plate 77
Site Q Ballplayer Panel 4	XII.23:501a:142var	Mayer 1978 [I]: no. 15, plate 26
Yaxchilan HS2, Step IX	XII.?:501a/b?	Graham 1982:163
Yaxchilan HS2, Step X	XII.220var:501a/b?	Graham 1982:163
Yaxchilan HS2, Step XII	XII.?:501a	Graham 1982:164
Yaxchilan HS2, Step XIII	XII.220var:501a	Graham 1982:164
K635, glyph I'4	XII.217var:501a	Coe 1973:103
K1383, glyph E	XII.220var:501a	Kerr 1989 [I]:78
K2803	XII?.23:501a$_{HV}$	Schele and Miller 1986:260

TABLE 1 (CONTINUED): GLYPHS ON RUBBER BALLS.

Inscription	Text	Reference
K4040	XII:1000g-var?	Photo in J. Kerr's online database (‹www.mayavase.com›)
13 *nahb'*		
Cobá, Hieroglyphic Step 1	XIII?.?	Con 2000: 41 [fig. 13c]; 44–45; Mayer 1988; 1991 [VI]: plate 12 bottom
Yaxchilan HS2, Step I	XIII.?:501a/b? (eroded so it is unclear whether filler or a real 13)	Graham 1982:156
14 *nahb'*		
Site Q Ballplayer Panel 1	XIV.23:501a$_{HV}$:142var	Schele and Miller 1986:257
K2912	XIV.220var:1000g.126?	Schele and Miller 1986:255
Eroded		
Yaxchilan HS2 Step XI	?.?:?	Graham 1982:164
K635, glyph I'6	Numeral coefficient must be 7, 8, or 9; the photo in Reents-Budet (1994:61) shows a 9 but the vessel has been restored between 1973 and 1994 (compare with the photo in Coe 1973:102)	Coe 1973:103
Ichmul de Morley Monument 1	probably 7 or higher; the subsequent glyphs are eroded	Graña-Behrens 2002:252; Mayer 1991 [VI]: plate 23 top
Other		
Chocholá vessel in the Cleveland Museum of Art (inv. No. 1990.180)	Hand (but no numeral)	Whittington (ed.) 2001:237 no. 111
Chichen Itza, Great Ballcourt, West and East Bench	Skull	Schele and Miller 1986:244
Chichen Itza, Great Ballcourt Stone	Skull	Wren 1991:54 Fig. 5
K5201 (Tiquisate vessel)	Skull	Leyenaar 1991:262 fig. 4; Whittington (ed.) 2001:167 no. 34
Copán, center marker from Ballcourt II-B	*k'an/k'a[h]n tuun*	Schele and Miller 1986:257
Ichmul de Morley Monument 2	VII.['Old Deer God']:*wa*	Graña-Behrens 2002:301; Mayer 1991 [VI]: plate 23 bottom
Chinkultik/La Esperanza Ballcourt Marker	"Jun Ajaw"	Navarrete 1984:Fig. 88
Itzimte Stela 4	2 Ajaw	Graña-Behrens 2002:29*f.*, 301; Von Euw 1977:13
Mucaancah Ballplayer Panel 2	BALL?:4?	Šprajc, García Cruz, and Ojeda Mas 1997:8–10
Tikal Group 6C-XVI Sub-21, mural	Head	Laporte and Fialko 1990:54, Fig. 3.18
Yaxchilan HS2 Step VI	Bound captive	Graham 1982:158
Yaxchilan HS2 Step VII	Bound captive	Graham 1982:160
Yaxchilan HS2 Step VIII	Bound captive	Graham 1982:162

TABLE 1 (CONTINUED): GLYPHS ON RUBBER BALLS.

Inscription	Text	Reference
PNK stone monument ("Lápida de Lacanhá")	Ball may have been marked but it is eroded and no details are discernible.	Navarrete 1984: Fig. 96
Vessel of unknown provenance (Hellmuth neg. no. 492795-12-Neg.12)	Ball has two glyphs, but details are not recognizable.	Hellmuth 1987a: Fig. 79, a and b

[a] The drawing of the inscribed ball on K4684 that is available on J. Kerr's webpage (‹www.mayavase.com›) suggests T585 **b'i** as the main sign, but it seems more likely – judging fror photo – that it is in fact a more symmetrical T501a **b'a**.

[b] The photo shows a '7' but the asymmetric arrangement of the dots makes a '9' more likely (see al discussion in Mayer 1991 [VI]:63).

minor variations include the head variant of T501a, and a suffixed row of dots that is presumably only ornamental (their number always exceeds the three dots that characterize T142 **ma**? [Figures 7b, 7c, 9a, and 9e]).

The rubber ball is in three cases not inscribed with glyphs but has the number 9 attached to it. A ballplayer plays the "9 ball" against a stairway in drawing 21 from Naj Tunich (Figure 8a). A similarly marked ball is shown in the ballcourt on a stone monument of unknown provenance (Figure 8b). Another "9 ball" on Caracol Altar 22 probably hints at the sacrificial ballgame death of a bound captive (Figure 8c). The combination of the number 9 with a rubber ball in the above examples parallels the numbered *nahb'* expression found on inscribed rubber balls. Grube and Nahm (1994:711) proposed for Panel 3 from La Amelia (Figure 7a) that the 9 *nahb'* expression in glyph A5b is equivalent to the scroll glyph (T576) in glyph A7, which they interpret as a rubber ball. The numbered ball substitutes for the numbered *nahb'* expression. This suggests that *nahb'* is closely related to the rubber ball.

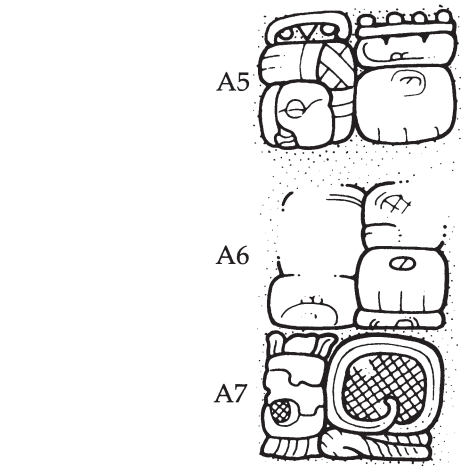
A hand appears as a superfix in sixteen cases. The hand is oriented with the palm down and grasps the main sign (usually the **b'a** glyph) with the thumb and the index finger, and the other fingers are extended (Figures 2, 9a to 9e). The thumb and the little finger are

TABLE 2: NUMBERED RUBBER BALLS

7 *nahb'*	1 example
9 *nahb'*	12 examples
9 BALL	3 examples
10 *nahb'*	2 examples
11 *nahb'*	1 example
12 *nahb'*	11 examples
13 *nahb'*	2 examples
14 *nahb'*	2 examples
Eroded	3 examples
Other	15 examples
Total	**52 examples**

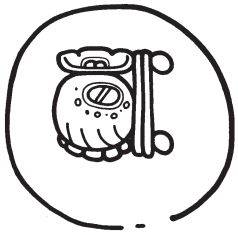
(BASED ON TABLE 1).

FIGURE 7: PHONETIC SPELLINGS OF *NAHB'*.



a

b



c

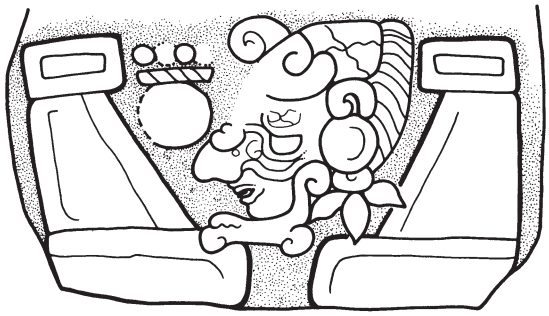
a: GLYPHS A5 TO A7 FROM LA AMELIA PANEL 2 (AFTER HOUSTON 1993:87).
b: INSCRIBED BALL FROM SITE Q BALLPLAYER PANEL 1 (AFTER SCHELE AND MILLER 1986:257).
c: DETAIL FROM SITE Q BALLPLAYER PANEL 4 (THE GLYPH BLOCK IS READ HERE FROM RIGHT TO LEFT; DRAWING BY M. EBERL AFTER MAYER 1978 [I]: PLATE 26).

spread over the main sign in these examples. The hand is clearly not grasping the main sign like a ball comparable to glyph F5b on Palenque's Tablet of the Slaves (a gesture that could be expected in this context), but it seems to measure it. This gesture is in four examples reduced to the extended palm that rests on the main sign (Figures 9f and g). Both variants substitute for each other (third glyph in Figure 10a and 10b), and Figure 9e provides an intermediate form.

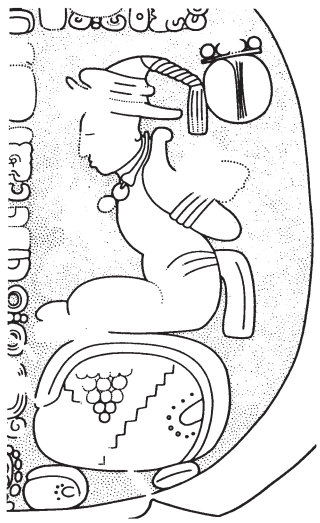
The graphic features and the position distinguish the ballgame hand from all other hand glyphs. The palm-down variant may be confused with the hand that touches the earth, a birth metaphor at Palenque (Lounsbury 1980:112–114). The latter, however, never shows the extended thumb that is characteristic of the ballgame hand. The position *above* the main sign differentiates the palm variant of the ballgame hand from the flat hand (**K'AL**). The ballgame hand glyph occurs in addition almost exclusively on inscribed balls or in related texts. We suggest that it constitutes a new glyph with two graphic variants that should be added to the growing catalogue of hand glyphs in Maya writing (see Palka 2002:434, and his fig. 11 for a preliminary overview; Boot 2003).[4]

FIGURE 8: "9 BALL" OCCURRENCES.

a



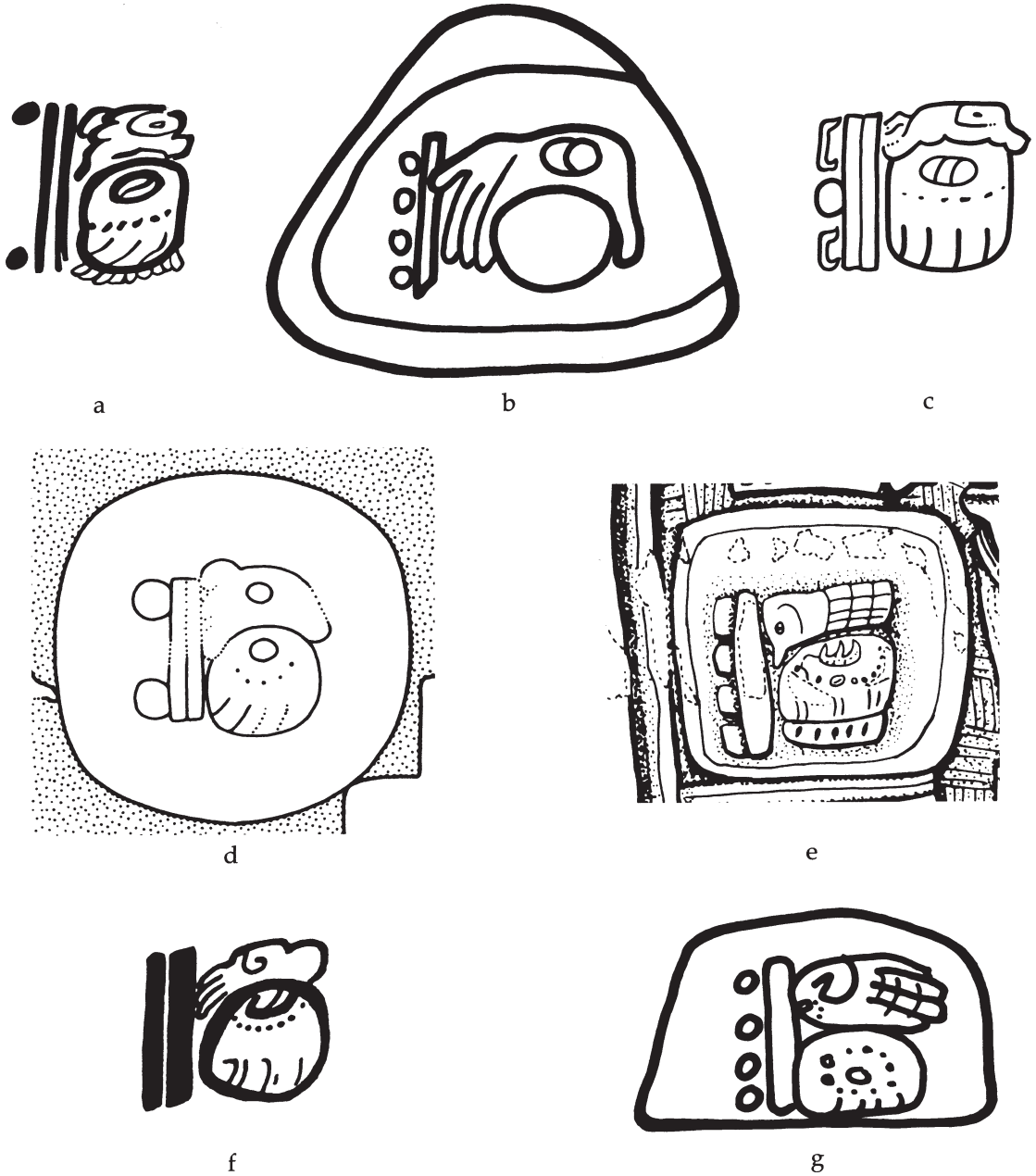
b



c

a: Drawing 21 from Naj Tunich (after Stone 1995:150).
b: The lower register of an unprovenanced monument that may have come from Estación Mojarras or Tonalá (drawing by M. Eberl after Mayer 1991 [VI]:plate 227, cat. No. 113).
c: Right captive from Caracol Altar 22 (after A. Chase, Grube, and D. Chase 1991:12).

FIGURE 9: THE SUPERFIXED HAND.



a: GLYPH E FROM K1383 (DRAWING BY M. EBERL AFTER KERR 1989 [I]:78).
b: DETAIL FROM THE CHOCHOLÁ STYLE VESSEL K5206 (DRAWING BY M. EBERL AFTER J. KERR'S ONLINE DATABASE [‹WWW.MAYAVASE.COM›]).
c: INSCRIBED BALL FROM CANCUEN BALLCOURT MARKER 2 (DRAWING BY M. EBERL).
d: INSCRIBED BALL FROM YAXCHILAN HIEROGLYPHIC STAIRWAY 2, STEP X (AFTER GRAHAM 1982:163).
e: DETAIL FROM A CHOCHOLÁ STYLE VESSEL ('BALLPLAYER I') (DRAWING BY J.T. HALES IN TATE 1985:130, FIG. 12).
f: GLYPH I'5 FROM K635 (AFTER COE 1973:103).
g: DETAIL FROM THE CHOCHOLÁ STYLE VESSEL K4684 (DRAWING BY M. EBERL AFTER KERR 1994 [IV]:589).

FIGURE 10: THE 'OLD DEER GOD' AND THE *NAHB'* EXPRESSION.

a: GLYPHS C1 TO E1 ON VESSEL K1383 (DRAWING BY M. EBERL AFTER KERR 1989 [I]:78).
b: GLYPHS H'3 TO I'4 ON VESSEL K635 (AFTER COE 1973:103).
c: GLYPHS F1 TO F3 ON VESSEL K3296 (DRAWING BY M. EBERL AFTER KERR 1992 [III]:403).

Marvin Cohodas (1991:261) has made the only previous allusion to this hand glyph. He identified it as an "eagle feather." This interpretation is, however, unlikely in view of the clear representation of the stylized wrist, fingernails, and other details of a human hand (Figure 9). One can proceed from the visual description and interpretation to the reading of the ballgame hand. A comparison of Figures 7 and 9 demonstrates that the ballgame hand is in all cases a superfix above the main sign **b'a** and that it replaces T23 **na** in this position. The latter substitution pattern suggests the syllable **na** as a possible reading for the ballgame hand. Alternatively, the ballgame hand could be the logogram **NA[H]B'** "handspan" (see below), with T501a **b'a** as a phonetic complement. Since the ballgame hand does not generally substitute for known **na** syllables, we prefer the logographic interpretation as **NA[H]B'**.

If the **NA[H]B'** reading is accepted for the ballgame hand, we would have an example for homophonous words that were disambiguated by using different glyphs. The ballgame hand represents *nahb'* "handspan," whereas glyph T625 represents *nahb'* "waterlily, water surface." Another example is the word *way*. Glyph T539 is *way* "co-essence, dream figure", whereas glyph T769 is—possibly in northern Yucatan only—*way* "room."

THE NUMBERED *NAHB'* EXPRESSION AS "HANDSPAN"

The various phonetic spellings of **na:b'a** (Figure 7 and Table 1) provide the basis for further interpretation. Scholars have preferred to read it as *nab'* or *naab'*, overlooking the seemingly slight difference between *nab'* (short internal vowel) and *naab'* (long or complex internal vowel). The recent discussion of disharmony in glyphic writing (Houston, Stuart, and Robertson 1998) suggested that Maya scribes differentiated internal vowel qualities. The concordant *a* vowels in the two syllables that spell **na:b'a** represent a synharmonic spelling that according to Houston, Robertson, and Stuart (2001:48 note 2) is unmarked and that can be used for words with or without complex vowels. In other words, the phonetic spelling **na:b'a** leaves the quality of the internal vowel unspecified. The search for the appropriate reading of **na:b'a** is further complicated by the discovery that some consonants are underrepresented in the middle and at the end of words. Grammatical rules and reconstructions of words suggest that preconsonantal *h*'s (CV*h*C) were rarely written in glyphic texts (Lacadena and Wichmann, in press). The unspecified internal vowel and the underrepresentation of consonants permit a variety of different readings for **na:b'a**.

Dictionaries of lowland Mayan languages contain several entries for the various possible readings of the phonetic spelling **na:b'a**. Linguistic considerations disqualify some dictionary entries. The lack of verbal or other morphology excludes verbs like *nab'* "to rub, itch, anoint." Other entries occur only in compounds (for example *pudznab* is attested in Colonial Yucatec for a deer with sharp, unbranched, antlers [Bolles 2001]). The most common entry is *nahb'* "still body of water" (e.g. lake or ocean). Many scholars adopted this translation because it fits the mythological interpretation of the ballgame. Linda Schele broadened Eric Thompsons' insight that the glyph for the day Imix represents a water-lily (Thompson 1950:72–73) and pointed out that the word for "still body of water" is homophonous with "water-lily" (Schele and Miller 1986:46, 60 note 51). She was thus able to interpret the frequent representations of water-lilies in Maya art as indications of scenes that take place under water and by further implication in the underworld.

Slightly less common is the translation of *nahb'* as "handspan" (Table 3 lists the dictionary entries in the Yucatecan, Ch'olan and Tzeltalan languages). Aulie and Aulie (1978:84) illustrate its usage in modern Ch'ol: *Jini lápiz an jun ñajb i chanlel* "this pencil is one handspan in length." Similar examples from other lowland Mayan languages reveal that *nahb'* "handspan" is generally used as a numeral classifier. Table 3 lists only the languages where *nahb'* is attested for "handspan." Dictionaries fail to provide corresponding entries for Ch'orti', but the remark of Charles Wisdom that a grave was dug "to a depth of about four feet, or five "hands" (spans)" (1940:303) suggests that a very similar measure was employed. The modern Chontal use *-c'a* "hand" as a numeral classifier (the free morpheme is *c'äb* "hand" [Incháustegui 1985:22; Keller and Luciano G. 1997:270–271, 483]). The dictionaries that are available for lowland Maya languages provide three translations for *nahb'* that are applicable: "still body of water," "water-lily," and "handspan."

The entries are rather uniform across lowland Mayan languages, permitting the reconstruction of the Proto-Ch'olan form as *nahb' (Kaufman and Norman 1984:126 no. 345). *Nahb' is easily reconciled with the glyphic expression. It was noted above that **na:b'a** is an unmarked synharmonic spelling that leaves the quality of the internal vowel unspecified. The vowel can either be short (*nab'*) or complex (e.g., *na[h]b'*). It is alternatively possible to explain the absence of the preconsonantal *h* in the glyphic spelling as the underrepresention of a consonant. We conclude that the Classic Maya used *nahb'* for "still body of water," "water-lily," and "handspan" (the form *nahb'* has, linguistically speaking, three homophonous morphemes). Of the three words, which one is the most appropriate in the context of the inscribed rubber balls?

The basic structure of a number followed by *nahb'* (Figure 6) corresponds to the syntax employed for numeral classifiers. Neither *nahb'* "still body of water" nor *naab'/nahb'* "water-lily" are attested as numeral classifiers. Only *nahb'* "handspan" satisfies this criterion (see the discussion below). The glyphs themselves provide an additional argument that favors the translation of *nahb'* as "handspan." The variants discussed above include the superfixed hand that seems to grasp the main sign (Figure 9). This gesture matches the way modern Maya measure handspans (Figure 11; see also Berlin 1968:158–161). Some dialects of modern Yucatec differentiate between at least two types of handspans (e.g., Miram 1983:300–301, no. 103).[5] The "small handspan" (Figure 11a), *čan náab'*, refers to the span between the thumb and forefinger, whereas *nohoč náab'* or "large handspan" (Figure 11b) refers to the distance between the thumb and the little finger. Daniel Brinton (1885:196–197) recorded three handspans among Yucatec Maya: *nāb*, from the tip of the thumb to the tip of the middle finger, *e nab* or little *nāb*, from the tip of the thumb to the tip of the index finger (the most popular hand span), and *chi nāb*, from the tip of the thumb to the tip of the little finger. Modern Tzotzil makes a similar distinction but employs different words (*-ch'utub* and *-ch'ix*; Breedlove and Laughlin 1993:562;

TABLE 3: DICTIONARY ENTRIES FOR *NAHB'* AS 'HANDSPAN.'

Colonial Yucatec	**naab** *sus. mat.* palmo o medida de palmo. **Hun naab, caa naab** *un palmo, dos palmos, etc.* **naabcuctah, -te** *vt. ide.* medir a palmos con hechizos, midiendo a palmos la vida del hombre, y el tal hechizo. **A uohel ua naabcuc?** ¿sabes este hechizo por ventura? **naabzah** *vt. con.* culpar a otro, echarle la culpa de lo que no ha hecho. **Tu naabzah bin u laak** dizque echó la culpa a su compañero. (Ciudad Real [1577] 1995:537–538)
Modern Yucatec	náab', stick, handspan; náab't, tv swim [crawl]; measure by handspans (Bricker, Po'ot Yah, and Dzul de Po'ot 1998:192)
Modern Itzaj	**naab' (1a)** n1a. *cuarta (vara).* quarter-rod, measure from outstreched thumb to little finger (8–9 inches). u-naab' a' winik-ej. *su cuarta del hombre.* the quarter-rod of the man. cf. b'aaraj // **-naab' (1b)** ncl. *cuarta (vara).* quarter-rod, measure from thumb to little finger (8–9 inches). *jun=naab' che'.* una cuarta de madera. a quarter-rod of wood. (Hofling 1997:468)
Modern Mopan	naab (n), cuarta: Ox naab u taan a che'e. La tabla mide tres cuartas de ancho. / naabnoc'ol (f), medidor (gusano): Jeda' ix naabnoc'ol. Allí está el medidor. / naabtic (vt), cuartear, medir con cuartas: Él está midiendo con cuartas. (Ulrich and Ulrich 1976:136)
Modern Ch'ol	**-ñajb** sufijo numérico para contar cuartas de la mano **Jini lápiz an junñajb i chanlel.** Este lápiz tiene una cuarta de altura (Aulie and Aulie 1978:84) najb handspans (Josserand and Hopkins 1988: NAH 2 II 88, page 2)
Colonial Tzeltal	nabuy medir a palmos. Nabughon, n.; nab medida así. Ghnab, chanab, etc.; nabil palmo o geme. Nabughel (Ara [1571] 1986:340)
Modern Tzeltal	nabuyel medir (pulgar a dedo corazón) (Slocum and Gerdel 1971:164)

(COMPILED BY THE AUTHORS)

Hurley Vda. de Delgaty and Ruíz Sánchez 1986:462). *Nabil* or *nabughel* "handspan" in Colonial Tzeltal (Ara [1571] 1986:340) survived into modern times as the measure from the thumb to middle finger (*nabuyel*); "handspan" as a measure is now called *stahn jc'abtic* (Slocum and Gerdel 1971:82, 164).

A closer look at the glyphic examples that employ the superfixed hand (Figure 9) shows that all hands conform to the *čan náab'* "small handspan" type, that is, the main sign does not lie between the thumb and little finger but between the thumb and the extended index finger. The consistent graphic representation suggests that the numbered *nahb'* expression on the inscribed rubber balls refers not only to "handspans" but even more specifically to the distance between the thumb and forefinger.

WHAT DOES THE NUMBERED *NAHB'* EXPRESSION MEASURE?

LENGTH ESTIMATES FOR "HANDSPANS"

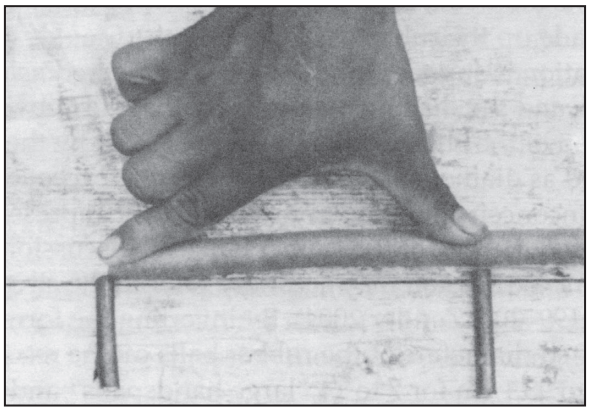
The preceding discussion presented different translations of the numbered *nahb'* expression and argued that *nahb'* on inscribed rubber balls probably refers to "handspan," a well-attested numeral classifier and measure. In recent years, several scholars have proposed the same translation (Coe 2003:199–200 [cited in Zender 2004:3 note 3]; Lacadena and Wichmann, in press; Macri 2000:29; Macri and Looper 2000:2; Zender 2002:404, 2004). This interpretation departs from the mythological context associated with the translation of *nahb'* as "ocean, water-lily." Its nature as a numeral classifier makes it also unlikely that *nahb'* refers to hand signals given by referees at ballgames (Christian Prager and Alexander Tokovinine, personal communication). This leaves, however, the question of what *nahb'* "handspan" measures.

Nahb' is commonly translated as *cuarta*, an Iberian unit of measurement that is synonymous with *palmo* "handspan" (*Diccionario de autoridades* 1970:386, 965). The traditional Spanish *cuarta* equaled one quarter *vara* "rod" or about 20.9 centimeters (and a little more than that in Spanish Latin America). It comes in modern Spain to 20 centimeters (Rowlett 2003). The dictionaries provide in some cases more detailed explanations. The Itzaj equate one handspan with 8 to 9 inches (about 20 cm to 23 cm), the Tzotzil with 20 cm (for *-ch'ix*), and the Ch'orti' with about 24 cm (Table 3 and above). From these it seems likely that *nahb'* approximates the Spanish *cuarta* in its traditional length of 20.9 cm. Less information is available on the "small handspan." We estimate its length to have been about 17 cm based on a 4 : 5 ratio that we took from the photo (Figure 11a) and measurements of our own hands.[6]

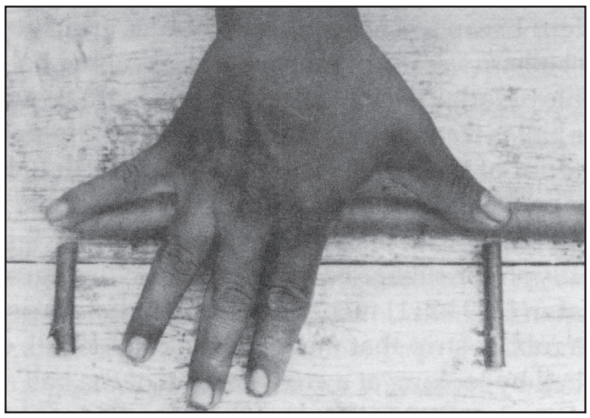
Were these lengths similar for the Classic Maya? Handspans can be assumed to correlate with overall stature. A comparison of the average stature of Classic and modern lowland Maya shows that it decreased for females from *c.* 1.47 to *c.* 1.44 m, and for males from *c.* 1.61 m to *c.* 1.56 m (Faulhaber de Sáenz 1970:102–103, Table 2; Tiesler Blos 1999, vol. 1:272). The decrease in average height from Classic to modern times is relatively small (3 and 5 cm, respectively), and it probably did not result in significantly different hand sizes. The height differences remain small even when social status is taken into account (Tiesler Blos 1999, vol. 1:274). The ballgame shown in Maya art was an elite affair, and people of higher social status tend to be taller than average.

The estimate of the total length recorded by the numbered *nahb'* expression must also consider the prefixed numbers. The numbers range from 7 to 14 (Table 2). They translate into a total length of 146.3 cm to 292.6 cm for the large handspan (thumb to little finger; estimated at 20.9 cm), and of 119 cm to 238 cm for the small handspan (thumb to forefinger; estimated at 17 cm; Table 4).

FIGURE 11: HANDSPAN AS UNIT OF MEASUREMENT IN MODERN YUCATEC MAYA.



a



b

a: *čan náab'* 'small handspan'.
b: *nohoč náab'* 'large handspan' (after Miram 1983:176, Fig. 54.1 and 54.2).

TABLE 4: ESTIMATES OF THE RUBBER BALL DIAMETER FOR VARIOUS INTERPRETATIONS OF *NAHB'*.

	Handspans	
***Nahb'* Interpretation**	**7–14 'large' (20.9 cm)** = 146.3–292.6 cm	**7–14 'small' (17 cm)** = 119–238 cm
nahb' measures the diameter	146.3–292.6 cm rubber ball diameter	119–238 cm rubber ball diameter
nahb' measures the circumference	46.6–93.1 cm rubber ball diameter	37.9–75.8 cm rubber ball diameter
nahb' measures the length of rubber strip	13.7–19.3 cm rubber ball diameter	12.3–17.4 cm rubber ball diameter

EXPLANATIONS FOR THE NUMBERED *NAHB'* EXPRESSION

We consider three alternative interpretations for these lengths. The numbered *nahb'* expression measures (a) the diameter, (b) the circumference of the rubber ball, or (c) the length of the rubber strip that made up the rubber ball (Table 4).

The first interpretation is suggested because the numbered *nahb'* expression is directly written on the rubber ball, and the diameter is probably the most obvious dimension of the rubber ball. The calculation of the absolute lengths represented by the numbered *nahb'* expression results—if interpreted as diameters—in rubber balls that exceeded the average height of the Classic Maya. This is inconceivable even in light of artistic representations (Figures 1 and 2) that probably exaggerated the size of the rubber ball (see discussion below).

The numbered *nahb'* expression may secondly refer to the circumference of the rubber ball (Boot 2003; Coe 2003:199–200; Zender 2004). By inverting the formula "circumference = × diameter ($2r$)", the supposed diameters of the rubber balls can be reconstructed. The diameters range from 46.6 cm to 93.1 cm for 7 to 14 "large handspans" and from 37.9 cm to 75.8 cm for 7 to 14 "small handspans."

Nahb' could alternatively refer to the length of the rubber strip that was coiled up to form the rubber ball. Modern Lacandon Maya, Tarahumaras, and Sinaloans still employ this technique to make rubber balls. CT scans of archaeological rubber balls confirm that they have a spiral inner structure (Filloy Nadal 2001:29 and 30, figs. 16–18). Lowland Maya art is equally explicit. The coiled rubber ball is framed by a stylized ballcourt on page 41a in the Dresden Codex (Figure 12). The interior of the ball is visible on Mucaancah Ballplayer Sculpture 2 (Figure 5b). The ballplayer on a ballcourt marker from Chiapas holds the wrapped ball in his left hand (Whittington 2001:172, no. 39). Floyd Lounsbury (1973:113) identified in addition the spiral (glyph T577) as the glyph for rubber ball (e.g. glyph A7 in Figure 7; see also the interpretation of Grube and Nahm [1994:711] mentioned above). If *nahb'* is alternatively considered as the measurement of the rubber strip that made up the rubber ball, one can estimate the resulting diameter of the ball by looking at a cross-section of the ball (a planar spiral) much like the one shown in the Dresden Codex (Figure 12). The coiled up rubber strip fills the area of the cross section of the rubber ball completely. The area of the cross section (πr^2) equals, in other words, the length times thickness of the rubber strip. The diameter of the rubber ball can then be calculated as $2([\text{Length} \times \text{Thickness}]/\pi)^{1/2}$. CT scans of Aztec rubber balls (Filloy Nadal

FIGURE 12: THE ROLLED-UP RUBBER BALL ON CODEX DRESDEN PAGE 41aA.

(DRAWING BY M. EBERL AFTER CODEX DRESDEN 1998)

2001:29 and 30, figs. 16–18) show the rubber strip to be approximately one centimeter thick. A rubber strip measuring 7 large handspans in length will then coil up to a ball 13.7 cm in diameter and 19.3 cm in diameter for 14 large handspans. It varies between 12.3 cm and 17.4 cm in diameter for 7 to 14 small handspans. These calculations are clearly only approximations, and the actual thickness of the rubber strip remains an unknown variable.

We compared the various interpretations for the numbered *nahb'* expression (Table 4) to depictions of rubber balls in Maya art, to archaeologically recovered rubber balls, to ethnohistoric and ethnographic descriptions of rubber balls, and to ballcourt rings.

RUBBER BALLS IN MAYA ART

Rubber balls are commonly part of ballgame scenes, and one can assume that the size of rubber balls in Maya art correlates with the size of rubber balls that were actually used. Marc Zender argued that the *nahb'* expression measures the circumference of rubber balls and pointed out:

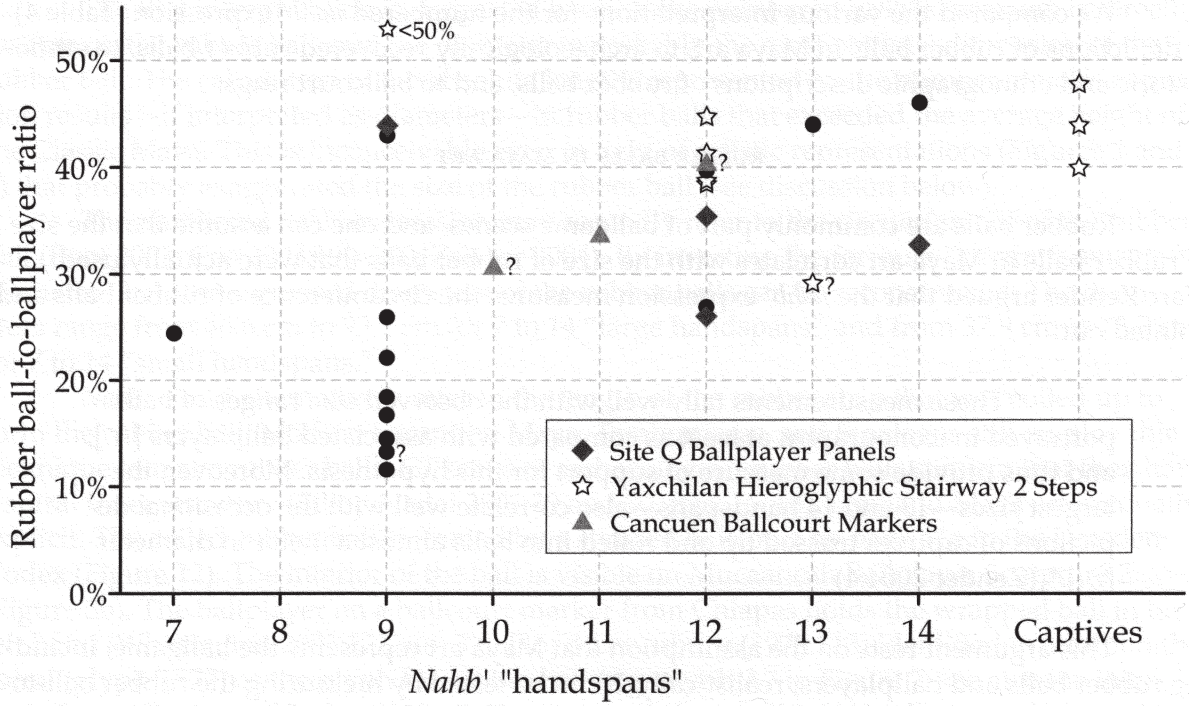
> "These measurements tally well with the observed size ranges of balls portrayed in iconography, at least as compared with associated ballplayers [...], and thus provide some measure of support for this hypothesis. Moreover, the largest sizes—13 and 14 handspans—also correlate well with the occasional depictions of captives trussed up and rolled into balls almost a meter in diameter [...]." (Zender 2004:4)

This argument rests on the assumption that Maya art represents the ballgame, including rubber balls and ballplayers, realistically. It can be tested by measuring the rubber ball-to-ballplayer ratio in ballgame scenes with rubber balls marked with the *nahb'* expression (Figure 13).[7] Low *nahb'* numbers which indicate small rubber balls should correspond to small ball-to-ballplayer ratios. The ratio should become larger with higher *nahb'* numbers, that is, larger rubber balls. We can expect, in other words, a positive and linear correlation between the rubber ball-to-ballplayer ratio and the numbered *nahb'* expression if rubber balls are represented realistically in Maya art. The correlation should exist regardless of the interpretation of the *nahb'* expression.

The 26 examples shown in Figure 13 exemplify the great variation in the representation of rubber balls in Maya art. *9 nahb'* rubber balls have ratios between 11.6% and 43.9%, whereas *12 nahb'* rubber balls have ratios between 26% and 44.8%. The overall impression of a positive correlation has to be qualified due to the few extreme *nahb'* values (namely 7, 13, and 14 *nahb'*). A comparison of ballgame scenes from the same site—where we would expect a consistent representation of rubber balls—illustrates the inherent variability (Figure 13). The rubber balls on the ballcourt markers from Cancuen, which have 10 (?), 11, and 12 (?) *nahb'* statements, increase correspondingly in size. The rubber balls on four Site Q ballplayer panels correlate negatively with the *nahb'* statements (that is, the largest rubber ball is marked with 9 *nahb'* and the smallest rubber ball with 14 *nahb'*). A similar negative correlation may apply to the six steps from Yaxchilan's Hieroglyphic Stairway 2.

The variable representation of rubber balls questions the basic assumption that Maya art faithfully portrays rubber balls (see also the discussion in Hellmuth 1987a:436–440). Additional influences may be found in artistic conventions (for example, the well-known exaggeration of the human head in Maya art; Clancy 1994; Miller 1999:158) or compositional considerations. The shape of the usually round rubber balls changes in scenes in which the rubber ball is near a ballplayer, the ballcourt, and/or the frame of the scene to a triangular (Figure 9b),

FIGURE 13: RUBBER BALL TO BALLPLAYER RATIOS IN BALLGAME REPRESENTATIONS IN MAYA ART.



(DIAGRAM BY THE AUTHORS)

(INCLUDED ARE THREE STEPS FROM THE HIEROGLYPHIC STAIRWAY 2 AT YAXCHILAN THAT SHOW CAPTIVES CURLED UP AS RUBBER BALLS.)

quadrangular (Figure 9e), or trapezoidal (Figure 9g) shape. We therefore hesitate to use artistic representations of rubber balls to evaluate interpretations of the *nahb'* expression.

ARCHAEOLOGICALLY ATTESTED RUBBER BALLS

Rubber is an organic material that deteriorates rather easily and that is therefore rarely attested archaeologically in Mesoamerica. The conditions appropriate to the preservation of rubber balls are met only at three locations: El Manatí in southern Veracruz, the Sacred Cenote at Chichen Itza, and Tenochtitlan (Filloy Nadal 2001:26–29). Twelve rubber balls were discovered at El Manatí. Ten measure between 8 and 15 cm and two up to 25 cm in diameter (one is depicted in Whittington 2001:138 no. 1). The dredging of the Sacred Cenote at Chichen Itza produced an unknown number of rubber balls, all of which measured only about 4 cm in diameter. Excavations under modern Mexico City resulted in the discovery of 17 rubber balls. The foundations of the Cathedral cover the main ballcourt of Tenochtitlan. The end zones of the ballcourt contained two offerings with miniature objects symbolically related to

the ballgame. Among them are two rubber balls that measure 7 cm in diameter. Offerings in the House of Eagles contained ten complete and two incomplete rubber balls. Their diameters range from 6 to 8.5 cm, and they have a groove that likely held the quill of a feather. Similar depictions of rubber balls in codices are identified as offerings. The rubber balls from the House of Eagles are the clearest example of the ritual use of rubber balls (see Stone 2002 for an extensive treatment of this subject), and it remains unclear whether they match balls used in the ballgame. Symbolic ballgame balls made of obsidian and alabaster are, however, with diameters of 11.5 cm and 11 cm similar in size (Fundació Folch 1992:218 no. 80 and 219 no. 81).

George F. Guillemin discovered the possible remains of a rubber ball in Burial 195 in Tikal's North Acropolis (Structure 5D-32). The burial dates to the seventh century A.D. and is the likely resting place of Animal Skull, Tikal's 22nd king. Among the grave goods was a three-ribbed ballgame yoke made of stuccoed and painted wood. Near the yoke "was found a darkened area of organic substance, about 6 inches (16 cm.) in diameter, that Guillemin thought to be the remains of a rubber ball." (Jones 1985:49) The 16 cm diameter of the possible rubber ball in Animal Skull's tomb would fit well into the 4 to 25 cm size range of archaeologically attested rubber balls.

Ethnohistoric and ethnographic accounts

Ethnohistoric and ethnographic descriptions of rubber balls tend to confirm the relatively small size of the rubber balls used in the ballgame. Juan Bautista Pomar (Pomar [1582] 1975:28) reports that the balls were as large as a medium-size human head. Other ethnohistoric sources provide similar estimates (Anghiera 1966:224; Durán 1967, tomo I:208; Benavente 1996:534). The rubber balls in the modern hip-ball game *ulama de cadera* measure maximally 20 cm in diameter (Filloy Nadal 2001:30; Leyenaar 1978:75 Fig. 70; Taladoire 1981:509).

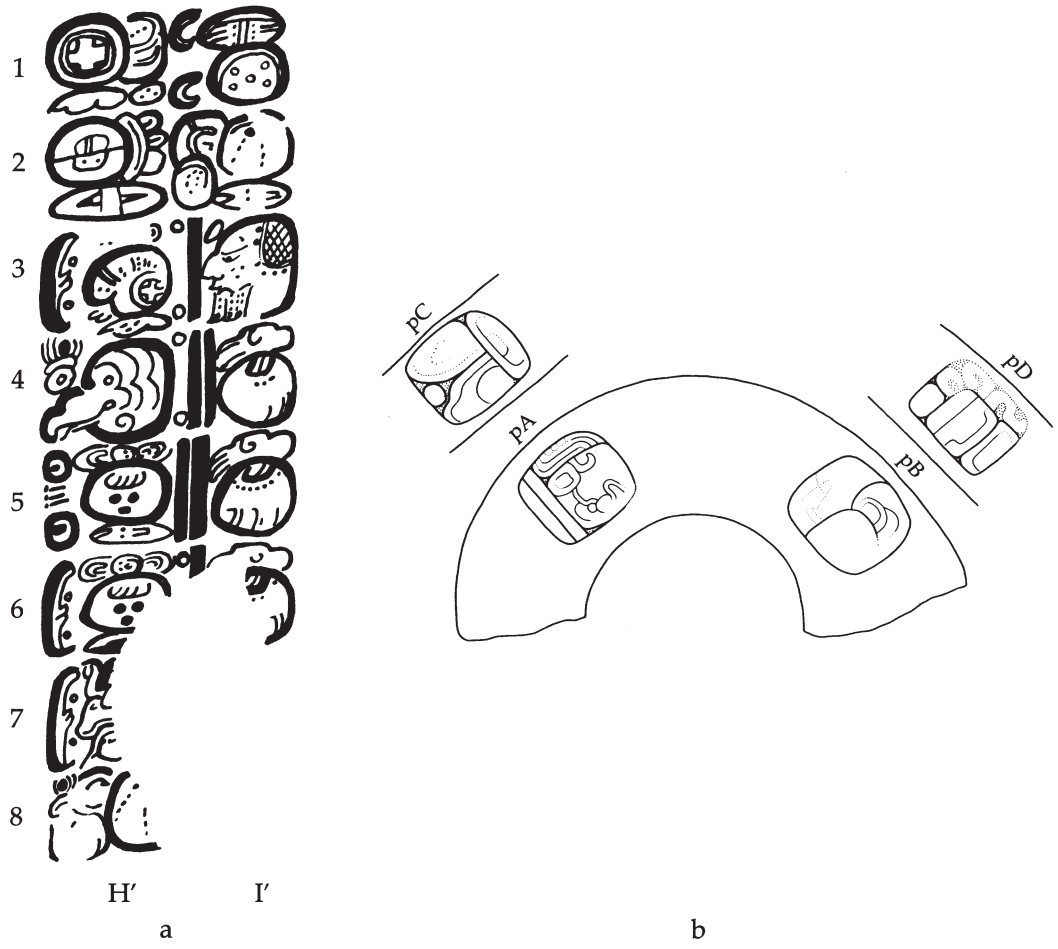
Ballcourt rings

Ballcourt rings provide another estimate for the size of rubber balls. The rubber balls had to pass through the hole of the ballcourt ring for a score and thus had to be smaller than the opening itself. In his early 16th century description of the ballgame, Fray Toribio de Benavente, who took the name Motolinía (1996:534; our translation), recalls that "They called upon someone who had the special gift of the devil to pass the ball through the opening of the stones and that had to be done by hitting [the ball] with the hip or the buttock." Classic Maya ballplayers likely scored in a similar way in courts with ballcourt rings. The fragmentary inscription on the ballcourt ring fragment from Naranjo (Figure 14b) refers, for example, to the ballcourt and the rubber ball (glyph pC).

The interior diameters of nine ballcourt rings from the Maya lowlands and 23 rings from the rest of Mesoamerica are listed in Table 4. The lowland Maya ballcourt rings have an average interior diameter of 41.8 cm (excluding the miniature ballcourt ring from Chichen Itza Structure 2D9), which is considerably larger than the openings of ballcourt rings from other areas of Mesoamerica that average only 23.9 cm.

The rather small openings of ballcourt rings outside the Maya lowlands were barely wider than the perhaps 20 cm thick rubber balls. "To get that ball through such a small opening by hitting it with the hip appears to be a miracle more than anything else," elaborates Motolinía (1996:534; our translation). "Because even if a man would use his hand and stand very close [to the ballcourt ring], he would not hit it once in one hundred, or in two hundred trials." A comparison with modern sports illustrates the difficulty of scoring in the Mesoamerican hipball game. A basketball hoop is 1.8 to 1.9 times larger than the diameter of the ball

FIGURE 14.



a: GLYPHS H′1 TO I′8 FROM THE 'FLEURS-DE-LIS' VESSEL K635 (AFTER COE 1973:103).
b: NARANJO BALLCOURT SCULPTURE 1 (AFTER GRAHAM 1980:187).

(FIBA 2000:14, 15), and the head of the crosse is 1.6 to 4.1 times larger than the ball in lacrosse (I.L.F. 1996:8). Rubber balls in Mesoamerican hipball were on the other hand only slightly smaller than the ring openings, they could not be hit with the hand, and they were mostly shot at a distance from the ring.[8]

The openings of ballcourt rings in the Maya lowlands—with an average diameter of 41.8 cm—are considerably wider than the openings of other Mesoamerican ballcourt rings. The difference is significant ($t_s = 0.0241$) and may reflect regional variants of the hipball game and changes over time (especially from the Classic Maya lowlands to the Late Postclassic Aztec).

Fortunately, two Maya sites permit the archaeological record and the epigraphic information to be brought together. The two ballcourts at Cobá (Structure XVII and in Group D) feature ballcourt rings with openings of 56 cm and 47 cm, respectively (Table 5). The Hieroglyphic Step 1 that was found in Group D (Con 2000:45) has a ballplayer scene with an inscribed ball. The glyphs can possibly be read as 13 *nahb'* (after the drawing in Con 2000:41 [fig. 13c]; for further discussion see Mayer 1988; 1991 [VI]: plate 12 bottom). Thirteen large

TABLE 5: THE OPENINGS OF BALLCOURT RINGS FROM MESOAMERICA (LIST OF THE AUTHORS).[1]

Location	Opening (diameter)	Reference
Lowland Maya ballcourt rings		
Chichen Itza Structure 2D1 Great Ballcourt	48 cm	Maudslay [1889–1902] 1974-III:plate 27; Stephens 1963 [1843]:205
Chichen Itza Structure 2D9 Ballcourt	2 cm	Ruppert 1952:24–25 (miniature ballcourt rings)
Cobá Structure XVII	56 cm	Con 2000:45; Thompson, Pollock, and Charlot 1932:47–48
Cobá Group D	47 cm	Con 2000:29–30; p.c. 2003; Thompson, Pollock, and Charlot 1932:78
Edzná, Structures 420-1 to 420-4	56 cm	Benavides 1997:72–73
Hochob	20 cm	Robina 1956:32
Naranjo, Str. B-32/33	19 cm	Graham 1980:187
Oxkintok, Str. DZ-10	58 cm	Rivera Dorado 1996:9, 36
Uxmal	60 cm	Ruz Lhuillier 1958:640
Xultun	12 cm	Graham 1980:187
Other Mesoamerican ballcourt rings		
El Baúl	20 cm	Thompson 1948:37–38
Kaminaljuyú, Silhouetted Relief 2	24 cm	Parsons 1986:plate 164
La Sierra	23 cm	Teresa Campos, pers. comm. 2002; Henderson *et al.* 1979:183
Tenochtitlan	20 cm	Martos López and Pulido Méndez 1989:82
Texcoco	21 cm	Blom 1932:498 note 15
Tula, Ballcourt 2	37 cm	Charnay 1885:73
Xochicalco South Ballcourt: north ring / south ring	32.5 cm / 31.2 cm	Personal observation
Xochicalco East Ballcourt: west ring	27.5 cm	Personal observation
Xochicalco North Ballcourt: ring 1 and ring 2	36.3 cm	Personal observation
Xochimilco	16 cm	Baquedano 1991:177, 178
El Transito	46 cm	Berlin 1946:16–17
Museo Nacional de Antropología (MNA) catalog no. 160	19 cm	Blom 1932:498 note 15

[1] No detailed information was available on the ballcourt rings from Ek' Balam and Yaxuna and at least 28 rings from other Mesoamerican sites; two otherwise unidentified ballcourt rings from the Museo Nacional de Antropología published in Fundació Folch 1992:216 no. 76 and 217 no. 77 are not listed because Blom's list (1932:498 note 15) may already contain them. The ballcourt ring at Okop had an interior diameter of at least 33 cm (Justine Shaw, personal communication 2003).

TABLE 5 (CONTINUED): THE OPENINGS OF BALLCOURT RINGS FROM MESOAMERICA

Location	Opening (diameter)	Reference
Other Mesoamerican ballcourt rings (continued)		
MNA catalog no. 161	16 cm	Blom 1932:498 note 15
MNA catalog no. 162	17 cm	Blom 1932:498 note 15
MNA no. 163	17 cm	Blom 1932:498 note 15
MNA no. 164	31 cm	Blom 1932:498 note 15
MNA catalog no. 551	8 cm	Blom 1932:498 note 15
MNA catalog no. 695 (paired with no. 756?)	23 cm	Blom 1932:498 note 15
MNA catalog no. 756 (paired with no. 695?)	23 cm	Blom 1932:498 note 15
MNA catalog no. 963	17 cm	Blom 1932:498 note 15
MNA catalog no. 693	20 cm	Blom 1932:498 note 15

handspans correspond to 271.7 cm which translates into a ball diameter of 86.5 cm (if *nahb'* measures the circumference) or 18.6 cm (if *nahb'* measures the length of the rubber strip); thirteen small handspans correspond to 221 cm and to a ball diameter of 70.4 cm or 16.8 cm (*nahb'* as circumference and as length of the rubber strip), respectively. The rubber ball mentioned on Cobá Hieroglyphic Step 1 would fit through either one of the two ballcourt rings only if *nahb'* refers to the length of the rubber strip.

A comparison of archaeology and epigraphy is also possible at Naranjo. Ian Graham recorded the fragment of a ballcourt ring—Ballcourt sculpture 1 near Structure B-32/33 (Graham 1980:187)—whose opening measures 19 cm in diameter (Figure 14b). The text of vessel K635 (Coe 1973:102–103; Figure 14a) contains three *nahb'* statements, two of which are readable as 10 (glyph I'5) and 12 *nahb'* (glyph I'4). The PSS attributes this vessel, whose actual provenience is unknown, to Itzamnaaj K'awiil, the penultimate ruler of Naranjo around A.D. 800 (Martin and Grube 2000:82–83). The 10 *nahb'* expression corresponds for large/small handspans to reconstructed ball diameters of 66.5/54.1 cm (*nahb'* as the circumference) and 16.3/14.7 cm (*nahb'* as the length of the rubber strip). The 12 *nahb'* expression translates into

ball diameters of 79.8/64.9 cm (large/small handspans with *nahb'* as the circumference) and 17.8/16.1 cm (*nahb'* as the length of the rubber strip). The hypothetical rubber balls would fit through the 19 cm opening of the Naranjo ballcourt ring only if *nahb'* measures the length of the rubber strip.

DISCUSSION

The total lengths represented by the numbered *nahb'* expressions range between approximately 1.5 to 3 meters for large handspans and between approximately 1.20 and 2.50 m for small handspans. Since the numbered *nahb'* expression occurs almost exclusively on rubber balls, and since the *nahb'* statement substitutes for rubber balls (Figure 8), we suggest that the numbered *nahb'* expression refers directly to the rubber ball and measures one of its dimensions. We offered three alternative explanations. The lengths could measure (a) the diameter, (b) the circumference of the rubber ball, or (c) the length of the rubber strip that made up the rubber ball. The comparison with depictions of rubber balls in Maya art, archaeologically recovered rubber balls, ethnohistoric and ethnographic descriptions of rubber balls, and ballcourt rings permitted us to evaluate the three alternative explanations.

The calculation of the absolute distances represented by the numbered *nahb'* expression rules it out as a measure of the diameter of the ball because the reconstructed balls would be larger than the average ballplayer. If *nahb'* refers instead to the circumference of the rubber ball, the resulting rubber balls would still be too large in comparison with archaeologically recovered specimens, and they would not have passed through most ballcourt rings. The last interpretation, which says that *nahb'* measures the length of the rubber strip that made up the rubber ball, results in ball diameters that are considerably smaller and that agree very well with the diameters of excavated rubber balls and the openings of ballcourt rings. This was made particularly clear through the direct comparison of numbered *nahb'* expressions from Cobá and Naranjo with ballcourt rings at the same sites. We conclude that the numbered *nahb'* expression refers to the length of the rubber strip that was rolled up to form the rubber ball.

NAHB' AS A NUMERAL CLASSIFIER

In our linguistic analysis of the numbered *nahb'* expressions, we argued that they have the structure of numeral classifiers. In many (but not all) Mayan languages, numeral classifiers are obligatory in quantifier expressions. John Lucy (1992:49) has described their structure as follows, using an example from Yucatec Maya:

> When counting or enumerating in these languages, an extra morpheme must also be used in addition to those expressing the number and the referent. This additional morpheme expresses or makes explicit further information about the nature of the referent. For example, whereas in English one can say *two turkeys* (i.e., number + plural lexical noun), in Yucatec Maya one must say *ka'a-túul 'úulum* (i.e., number + extra morpheme + neutral lexical noun).

In this example, the numeral classifier *(túul)* qualifies the noun *('úulum)*, indicating that it refers to an animate being. The same classifer must be used for humans (e.g., *ka'a-túul wíinik* "two men") because they are also animate.

The bond between the number and the numeral classifier is stronger than the bond between the numeral classifier and the noun to which it refers. In contexts where the nominal referent is clear, the classifier and its number may be used anaphorically without mentioning

the quantified noun. Thus, if it is previously understood that turkeys are the topic of a conversation, they can be referred to as *ka'a túul* alone; it is not necessary to use the longer expression—*ka'a-túul 'úulum*—because no one would confuse them with two men *(ka'a-túul wíinik).* The same is true in Chontal, where "all quantifiers may be used in constructions without a noun if the noun has been mentioned earlier in the discourse and/or the referent of the quantifier is understood from the context" (Knowles 1984:283).[9]

Numeral classifiers that function as adverbs never co-occur with nouns (Knowles 1984:284; see also Lucy 1992:199 note 9). *lúub'* "league" and *téen* "times(s)" are examples of such adverbial classifiers in Classical and Modern Yucatec: *hun lúub'* "one league" and *ka'a téen* "twice, again." *lub* had a different meaning ("time[s]") in Classical Chontal, but occurred in similar syntactic contexts:

> u kal *ux lub chan lub* u thani tak ba, "because he spoke to me *three times* (or) *four times*" (Smailus 1975:59).

The temporal classifier *hab* "year" could also have such an adverbial function in Classical Chontal:

> *hun hab* u numeli castillan uinic, "*one year* after the Spaniards came" (Smailus 1975:64).

In Modern Chontal, *hap'* "years in the future," *häb* "years in the past," *petz'* "times," and *num* "time(s)" behave in the same way (Knowles 1984:284–285). Comparable expressions exist in Ch'orti' as well (Fought 1967:152–153).

The contrast between the adverbial and non-adverbial functions of numeral classifiers can be seen most clearly in Classical Yucatec in terms of the temporal classifier *kin* "day."[10] The following couplet from the Book of Chilam Balam of Chumayel exemplifies the non-adverbial use of this classifier in combination with a neutral lexical noun:

> lay u chun *ca kin* xec *ca kin* ahaulil, "this is the origin of the *two-day* seat, the *two-day* reign" (Gordon 1913:20).

Adverbial examples in which the numeral classifier is not followed by a noun come from the Ritual of the Bacabs, a book of medical incantations:

> *can kin* cu sut be, "for *four days* he returns on the road" (Arzápalo Marín 1987:128).
>
> *hun kin* ca sihi, "on *one day* he was born" (1987:109).
>
> *can kin* cu tokic *can kin* cu katic, "for *four days* he burns it, for *four days* he requests it" (1987:63).
>
> *hun kin* cu chibal u uich u, "for *one day* the face of the moon is bitten" (1987:113).

To date, few numeral classifiers have been identified in Maya hieroglyphic texts (Boot 2002:111; Kelley 1976:190–192; Love 1989:348; Macri 2000; Stuart and Houston 1994:13–14), and those that are known are primarily concerned with units of time (e.g., *b'ix* for periods of five or seven days) (Stuart 1987:31–33; Thompson 1950:170–171). Objects such as incense balls,

tortillas, and chocolate beans are usually quantified without classifiers interposed between the number and the noun, suggesting that they are underrepresented in the script. *Nahb'* "handspan" is, in fact, the first numeral classifier that has been recognized as a measure of length.

Cognates of *nahb'* "handspan" have been attested in three Yucatecan languages (Classical and Modern Yucatec, Itsaj, and Mopan) (Arzápalo Marín 1995:537–538; Beltrán 1859[1742]:203–208 [republished in Tozzer 1921:291]; Bricker, Po'ot Yah, and Dzul de Po'ot 1998:192; Hofling 1997:468; Miram 1983:176; Ulrich and Ulrich 1976:136) and one Cholan language (Ch'ol) (Aulie and Aulie 1978:84). In Modern Yucatec, *náab'* can be used for measuring cloth, as in *'óoš náab' nòok'* "a three-handspan length of cloth," and Hofling (1997:468) provides an example of *jun-náab' che'* "a quarter-rod of wood" in Itsaj. We have found two examples of the use of this numeral classifier in Classical Yucatec, both in the Book of Chilam Balam of Chumayel:

> mehene ca a tales ten yx canan col, "Son, bring me a protectress of fields,"
>
> yx nuc ek tun lah u uinicile, "an old woman whose body is completely dark then,"
>
> *uuc nab* u tan y itte, "whose buttocks are *seven handspans* across!" (Gordon 1913:41).
>
> mehene cex ix nuc, "Son, where is the old woman"
>
> *uuc nab* u tan y ite, "whose buttocks are *seven handspans* across?" (Gordon 1913:68).

In these examples, *uuc nab* "seven handspans" is part of an equational sentence that can be translated literally as "seven handspans are her buttocks." The sentence consists of two parts: a numeral classifier expression *(uuc nab)* and a noun phrase inflected for possession *(u tan y it)*. Therefore, it is an example of a numeral classifier that is not immediately followed by a neutral lexical noun. Such constructions also exist in Mopan:

> *ox naab* u taan a che'e, the table measures *three handspans* in width (literally, "three handspans is the table across") (Ulrich and Ulrich 1976:136),

and Ch'ol:

> jini lápiz an *jun ñajb* i chanlel, "this pencil is *one handspan* in length" (Aulie and Aulie 1978:84).

These examples suggest that *nahb'* could have been used with or without the neutral lexical noun. Inscribed on a ball, numbered *nahb'* expressions can simply refer to the size of the ball, or the ball itself can substitute for the noun.

CONCLUSIONS

Our investigation of inscribed rubber balls focused on the numbered *nahb'* expression. The 34 *nahb'* examples (out of a total of 52 cases) we were able to document allowed us to make a thorough epigraphic and linguistic analysis. The glyphs involved consist of a number

from 7 to 14 followed (in the phonetically most transparent case) by **na:b'a**. The transliteration of the latter as *na[h]b'* corresponds to Proto-Ch'olan *nahb' for "still body of water," "water-lily," and "handspan." The previous interpretations of the numbered *nahb'* expression favored the first two translations. We directed attention to the translation as "handspan" on the basis of our linguistic analysis—a number followed by a numeral classifier—and the glyphic substitution of **na:b'a** by a "measuring" hand over a **b'a** sign. The superfixed hand which appears in two graphic variants probably represents a handspan, and we propose that it is the logogram **NA[H]B'**. The gesture itself is still attested in modern lowland Maya cultures as a unit of measurement that is known as *nahb'* or *náab'* in most lowland Mayan languages. Modern Yucatec, Tzotzil, and Tzeltal distinguish further between a "large handspan"—the distance between thumb and little finger (approximately 20.9 cm)—and a "small handspan," the span between thumb and forefinger (approximately 17 cm). Since the superfixed hand on inscribed rubber balls is always the latter, we conclude that the Classic Maya referred to *nahb' "handspan" in the ballgame context and probably specifically to "small handspan." *Nahb'* would thus become the first unit of length attested for Classic Maya culture. Our epigraphic argument supplements Daniel Brinton's linguistic analysis (1885) and the reconstruction of measurement units based on architectural measurements (O'Brien and Christiansen 1986). The variation noted for measurement units used by modern Maya (e.g., Carlsen 1997:178–179 note 8 regarding the *cuerda*) suggests that *nahb'* was not standardized in the sense of modern measurement units. Individual hand sizes and regional traditions probably influenced the actual length of a *nahb'* handspan.

We also considered what the numbered *nahb'* expression measured. The possibilities are limited by depictions of rubber balls in Maya art, archaeologically recovered rubber balls, ethnohistoric and ethnographic accounts of the ballgame, and ballcourt rings, and we suggested that the numbered *nahb'* expressions refer to the length of the rubber strip that was rolled up to form the rubber ball. It provides a measurement of the size of the rubber balls that were used in the Maya ballgame. The seven numbers that occur in *nahb'* expressions imply an equal number of different rubber balls and suggest an equal number of ballgame variants.

The numbered *nahb'* expression also has interesting linguistic implications. We have shown, first of all, that it is a numeral classifier and, to date, the first measure of length that has been identified in Precolumbian Maya writing. Furthermore, hieroglyphic *nahb'* is a numeral classifier that does not have to be followed by a neutral noun, a characteristic it shares with its cognates in Colonial and Modern Cholan and Yucatecan languages. And because, as we have shown, neutral nouns are not obligatory and are occacionally prohibited after some numeral classifiers, the possibility exists that there are other numeral classifiers in the Maya script that have not been identified by epigraphers because their view of the structure of such expressions was too narrow. Armed with this broader understanding of the syntax of numeral classifiers, we expect that epigraphers will be able to enlarge the corpus of known examples of this striking feature of the Cholan and Yucatecan languages.

ACKNOWLEDGEMENTS

The inspiration for this paper came from the exhibition called "The Sport of Life and Death: The Mesoamerican Ballgame" at the New Orleans Museum of Art during the spring of 2002, which was organized by E. Michael Whittington. We would like to thank several scholars who provided us with unpublished materials or further information. Jack Sulak and Ivan Šprajc made detailed photographs of the ballplayer sculptures from Mucaancah available. Christian Prager called our attention to the possible *nahb'* example on Calakmul Stela 66, and Phil Wanyerka shared the 7 *nahb'* example on Lubaantun ballcourt marker III. Justyna Olko helped with ballcourt rings from Mesoamerica. Rosemary Joyce and Teresa Campos provided information on the ballcourt ring from La Sierra, Justine Shaw on the ballcourt

ring fragment at Okop, and Maria José Con on the ballcourt rings from Cobá. Arthur Demarest made the new Cancuen ballcourt markers available. We are grateful to Karl Hoffman and Frank Reifler for their help with the formula for calculating the diameter of balls composed of rolled-up strips of rubber of different lengths. Robert M. Laughlin cheerfully corrected his length estimate for the Tzotzil numeral classifier *–ch'utub*. Judith Maxwell provided useful advice on linguistic terminology. Ramzy R. Barrois, Erik Boot, Christian Prager, Jack Sulak, Alexandre Tokovinine, and the anonymous reviewers provided very useful suggestions and criticism.

NOTES

[1] The tied captives from Yaxchilan remind us of similar representations at Tikal, namely on Altar 5, Col. Altar 1, Col. Altar 2, and Col. Altar 3 (Jones and Satterthwaite 1982:Fig. 30; Fig. 62b; Fig. 62c; Fig. 62d).

[2] The transliteration and transcription of Maya glyphs employ the system used in Thompson's catalogue (1962) and the guidelines set up for the series, Research Reports on Ancient Maya Writing (G. Stuart 1988).

[3] Eric Thompson subsumed in his glyph catalogue (1962) two graphically different glyphs under T501. The interior spot is marked by diagonal stripes in T501a (which is read as **b'a**), whereas it is cross-hatched in T501b, the "darkened *imix*" that is read as **ha** or possibly **NA:B'** (Ringle and Smith-Stark 1997:303, 347; Stuart and Houston 1994:19). Both glyphs can refer to the calendar day Imix.

[4] Thompson's glyph catalogue (1962) does not do justice to the variety of hand glyphs in Maya writing, and the ballgame hand is transcribed in Table 1 as T217var and T220var due to the insufficient differentiation of signs in the catalogue.

[5] Helga-Maria Miram conducted her work (1983) in Pixoy. The Yucatec dialect spoken in Hocabá uses *náab* for 'handspan' and *hat-k'ab'* to designate the distance between the tip of thumb and the index finger (Bricker, Po'ot Yah, and Dzul de Po'ot 1998:192, 98). The use of different words in Hocabá raises the question of which kind of "handspan" was primary and which derivative.

[6] Dennis E. Breedlove and Robert M. Laughlin (1993:562) equate the modern Tzotzil classifier *-ch'utub*, which measures the span between the thumb and the forefinger, with about 10 cm. Robert M. Laughlin (personal communication, 2003) has corrected the figure to 15 cm (see also Hurley Vda. de Delgaty and Ruíz Sánchez 1986:462).

[7] Of course, the height of ballplayers influences the rubber ball-to-ballplayer ratio. We were able to control that source of variation by averaging the height of the ballplayers in scenes with multiple ballplayers. The latter account for almost half of the 26 ballgame scenes represented in figure 13 (eleven examples or 42.3%).

[8] Eric Taladoire (1981:459) argued that the inner diameter of ballcourt rings correlates with the height of the ring above the ground since the higher the ballcourt rings were installed above ground the less accessible they became for ballplayers. His argument makes sense, but it cannot be corroborated statistically. The actual or reconstructed placement of ballcourt rings is known for only five rings from the Great Ballcourt at Chichen Itza, Structure XVII at Cobá, Edzná, Oxkintok, and Uxmal. If the Great Ballcourt is removed (it is the literal tail that wags the dog because it creates statistically significant correlations), the height above ground and the inner diameter of ballcourt rings do not correlate (Pearson's $r = 0.07$). The sample size is, however, very small.

[9] Brent Berlin (1968:20) also recognizes the anaphoric use of numeral classifiers in Tzeltal in his formula for their structure as *specific numeral + numeral classifier ± noun*, where the neutral lexical noun is not obligatory.

[10] It can be argued that the glyphs for the *baktun, katun, tun, uinal,* and *kin* that are found in initial series and distance number expressions are numeral classifiers with an adverbial function and for that reason are not followed by neutral nouns. Further linguistic analysis has to take into account examples like Piedras Negras Panel 2 (Prager 2003:3–4) and Yaxchilan Stela 11 in which **TE'**—presumably as numeral classifier—intervenes between number and period glyph (Erik Boot and Christian Prager, personal communication 2003).

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