

Malay mathematics based on Terengganu Inscription

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Abstract. We exhibit the Malay Mathematics in the 14th century Terengganu Inscription dated 702H, that is 1303. There are several mathematical elements that we classify as Malay numbers (cardinal and ordinal), units of measurement, position (location and position in a family), elements of logic, and time (day, month and year). We also give an equivalent amount of fine imposed to convicts as listed in the inscription.

Key words: malay mathematics, malay numbers, measuring unit, position, elements of logic

Introduction

The Terengganu Inscription contains many mathematical elements that could be classified as numbers (cardinal and ordinal), units of measurement, position (location and positions in a family), elements of logic, and time (day, month and year) (Abdul Razak 2002, 2010a, 2010b). In this working paper we discuss the Malay Mathematics based on these mathematical elements. We also give an equivalent amount of fine imposed to convicts as listed in the stone inscription.

The Terengganu Inscription was engraved in 702H (1303), which was towards the end of the Middle Age in Europe (1100-1300) and the beginning of Renaissance (1300-1700), when people were actively involved in the discussions on philosophy. The activities of philosophers during the Renaissance mainly focused on the arguments between intellectuals against people of the church who were in power (Shaharir 2000a).

Materials and Methods

We studied the mathematical elements obtained in the Terengganu Inscription which we classify as numbers (cardinal and ordinal), units of measurement, position (location and positions in a family), elements of logic, and time (day, month and year). For convenience we shall refer to the Transcription of Terengganu Museum (TTM) and the English Transcription (ET) prepared by the Terengganu Museum, and the Popular Transcription of Terengganu Inscription (PTTI) of Al-Attas (1970, see also Othman & Abdul Halim 1990). We now list all the mathematical elements found in the Terengganu Inscription.

Results and Discussion

Malay numbers

The Malay numbers (cardinal and ordinal) on the Terengganu Inscription are given as follows:

<i>Paha</i> (side C, D)	quarter (old literature)
<i>Tengah tiga</i> (side C)	two and a half
<i>Se</i> (side B, C, D)	one
<i>Asa</i> (side A)	one
<i>Lima</i> (side C)	five
<i>Tujuh</i> (side C)	seven
<i>Sepuluh tengah tiga</i> (side C)	twelve and a half
<i>Seratus</i> (side B)	one hundred
<i>Tujuh ratus dua</i> (side A)	seven hundred and two

Fraction comes from the word (number) **tengah tiga** (mid three; side C, line 3) which means *two and a half* ($2\frac{1}{2}$), while **sepuluh tengah tiga** (ten mid three; side C, line 1) means $12\frac{1}{2}$. Note that the word **sepaha** (literally means "a thigh"; side C, lines 2 and 4; side D, line 1) means *a quarter*.

In old Malay language the concept of **belas** (teen) did not exist. Such numbers were expressed as addition, for instance **sepuluh dua** (ten two), that is **sepuluh tambah dua** (ten plus two) for **dua belas** (twelve) and so on (Asmah 1995). This is similar to Arabic language, in saying "*ithnin asyara*" for twelve etc. Therefore the word **sepuluh tengah tiga** (ten two and a half; side C, line 1) means twelve and a half ($12\frac{1}{2}$), that is 10 plus $2\frac{1}{2}$.

Large numbers on the Terengganu Inscription are **seratus** (one hundred; side B, line 9: *seratus ratun* or *sa-ratus rautan*), and **tujuh ratus dua** (seven hundred and two; side A, line 11: the Hijrah year the engraving of the stone was completed).

All the numbers, **tengah tiga** (two and a half), **se** (one), **dua** (two), **lima** (five), **tujuh** (seven), **sepuluh tengah tiga** (twelve and a half), **seratus** (one hundred) and **tujuh ratus dua** (seven hundred and two) engraved on the stone are spelt in Jawi (Arabic) alphabets, and Malay numerals which have existed since the seventh century, were not used (Abdul Razak 2009; Shaharir 2000b) (Table 1).

Table 1. Malay numerals since 7th century

Kurun	sifar	satu	dua	tiga	empat	lima	enam	tujuh	lapan	sembilan
5M		١	٢	٣	٤	٥	٦	٧	٨	٩
Hindu Purba	•	१	२	३	४	५	६	७	८	९
7M	•	١	٢	٣	٤	٥	٦	٧	٨	٩
Rencong	•	١	٢	٣	٤	٥	٦	٧	٨	٩
13M		١	٢		٤				٨	٩
14M	٧			٣		٥	٦	٧	٨, ٩	
Kini (Jawa)	•	١	٢	٣	٤	٥	٦	٧	٨	٩
Hindiyah	•	١	٢	٣	٤	٥	٦	٧	٨	٩
Ghubariyah	0	1	2	3	4	5	6	7	8	9

Source: Abdul Razak, 2009

The Arab al-Hindiyah (Jawi) numerals were used in a Malay letter in the year 1786, a letter from Sultan Ibrahim of Selangor to Francis Light. The date of the letter was spelt in Jawi alphabets. The Arab al-Ghubariyah numerals, namely the year 1190 Hijrah (which looks like 1140) was found on the rubber stamp of a letter from Paduka Seri Sultan Ratu Seri Ingalaga of Jambi to Francis Light in 1776 (Gallop 1994).



Figure 1. Logos of PERSAMA and NSMS

Current application of the above numerals are to the logo of the Malaysian Mathematical Sciences Society (Persatuan Sains Matematik Malaysia (PERSAMA)) designed by the author in 1995, which used the current Javanese numerals for the year 1970, the date the society was established, and the logo of the National Symposium of Mathematical Sciences (NSMS) which was also designed by the author in 2002 which used the 7th century's numerals and Rencong numerals for 1982, the year that we started the NSMS (Figure 1).

Ordinal numbers

Ordinal numbers in the Terengganu Inscription are as follows:

Side B

Line 2: *(Datang berikan. **Keempat** orang berpiutang.*

Cometh hither to tell ye. The **Fourth** Commandment for debtors.

Line 4: ***Kelima** derma barang orang ... (mar)dika.*

Fifth Commandment give thee alms and pay thy lithes.

Line 6: *Jika ia ambil hilangkan emas. **Keenam** derma barang*

If taketh thee the gold, return it.

This means that the words **Pertama** (first), **Kedua** (second) and **Ketiga** (third) could have been engraved on side B of the inscription which has not been found until today.

Side C

Line 5: *Merdeka. **Ketujuh** derma barang perempuan hendak ...*

Free man. The **Seventh** Commandment; dowry for woman should ...

Side D

Line 1: *... tiada benar dendanya setahil sepaha **kesembilan** derma.*

... false evidence, the fine a 'tahil' and a 'paha' Commandment **Nine**.

Line 3: *... **Ke sepuluh** derma jika anakku atawa pemainku atawa cucuku atawa keluarga ku atawa anak.*

... My children, my uncles, my grandchildren and family and their siblings.

Surely condition **Kelapan** (eighth) could have been on side D of the missing part.

Units of measurement

On sides C and D of the inscription we find units of measurement for **amount** (probably for gold) which were probably used by the convicts to pay their fine. The units of measurement are as follows:

Tahil (side C, D)

Paha (side C, D)

Saga (side C, ET)

Side C

5 tahlil	204.12 gm	RM 34,700.40	IDR 97,473,033.71
7¼ tahlil	295.974 gm	RM 50,315.58	IDR 141,335,898.88
12½ tahlil	510.3 gm	RM 86,751.00	IDR 243,682,584.27
(5 tahlil	204.12 gm	RM 27,964.44	IDR 78,551,797.75
7¼ tahlil	295.974 gm	RM 40,548.44	IDR 113,900,112.36
12½ tahlil	510.3 gm	RM 69,911.10	IDR 196,379,494.38)

Position

Position is a mathematical element representing location/position of an individual, and also position of an individual in his/her family.

Location/Position

Side A

Line 4: **Di Benuaku** ini penentu agama Rasulallah sallallahu wassalama raja.

On this land, the religion of the Holy Prophet shall prevail.

Line 5: *Mandalika yang benar bicara sebelah Dewata Mulia Raya* **di dalam**

The Holy Prophet, the upholder of truth **in Thy kingdom**.

Line 6: **Bumi** penentuan itu fardhu pada sekalian Raja Manda

Hear ye kings, these messages.

Line 9: *Tuhan menduduki Tamra ini* **di Benua Terengganu** adi pertama ada.

Be it known, **the land of Terengganu**, the first to receive messages of Islam.

Side B

Line 1: *Keluarga* **di Benua** jauhkan

Brethren **of lands** distant

Position in a family

In a (Malay) society, position in a family can be categorized as follows:

Buyut (saudara)	great-great grandparents
Moyang/nyang (saudara)	great grandparents
Datuk/ninik/nenek/uwan (saudara)	grandparents
Ayah/bapa/bapak/emak/ibu (saudara)	parents
Ego	ego
Anak (saudara)	children
Cucu (saudara)	grandchildren
Cicit (saudara)	great grandchildren
Piut (saudara)	great-great grandchildren

Side D

Line 3: ... *Ke sepuluh derma jika* **anakku** atawa **pemainku** atawa **cucuku** atawa **keluarga** ku atawa anak.

... My **children**, my **uncles**, my **grandchildren** and **family and their siblings**.

The above information implies that during that time Mandalika had **children**, **grandchildren**, and other **family members**. He did not have his parents around since he was only referring to his **uncles**.

Elements of logic

Other than the Malay numbers (cardinal and ordinal), units of measurement and positions mentioned above, in the Terengganu Inscription, there are quantifying words, existence, conjunction and implications, as listed below:

Ada (side A)	exist
Atawa (side B, D);	or
Barang siapa (side D)	whoever
Benar (side A)	true
Jangan (side B)	do not
Jika (side B, C, D)	if
Maka (side A)	then
Segala (side D)	all
Sekalian (side A)	all
Tiada/tida (side C, D)	no

Words such as **dan** (and), **atawa** (or), **tiada** (no/not), **sekalian** (all), **segala** (all), **jika** (if) and **maka** (then) are basic concepts in logic, and are used in fuzzy logic. The symbols or notations for these words are given as follows:

For statements p and q ,

p and q	is written	$p \wedge q$
p or q	is written	$p \vee q$
not p	is written	$\sim p$
if p then q	is written	$p \Rightarrow q$
for all x	is written	$\forall x$

In the Terengganu Inscription:

1. Side A:

Line 3: *Dengan benar bicara derma mereka **bagi sekalian** hamba ...*
With Islam, truth revealed **to all** Thy creatures.

Line 6: *Bumi penentuan itu fardhu **pada sekalian** Raja Manda*
Hear ye kings, these messages.

These are of the form $\forall x$.

2. Side C, line 3:

*Tengah tiga, **jika tetua bujang dandanya lima ta(hil)** ...*
Two and a half 'saga', **the fine for older singles ...**

This is of the form $p \Rightarrow q$,

where p = older singles

q = the fine is five tahils

3. Side D, line 1:

... **tiada benar dendanya setahil sepaha** kesembilan derma.

... **false evidence, the fine a 'tahil' and a 'paha'** Commandment Nine.

This is of the form $\sim p \Rightarrow q$,

where p = evidence, and so $\sim p$ = false evidence

and q = the fine a 'tahil' and a 'paha'.

4. Side D, line 3:

Ke sepuluh **derma jika anakku atawa pemainku atawa cucuku atawa keluarga ku atawa anak**

... **My children, my uncles, my grandchildren and family and their siblings.**

Take p = my children

q = my uncles

r = my grandchildren

s = my family

t = their siblings? (*anak mereka*)

u = donation

Thus we have the form $p \vee q \vee r \vee s \vee t \Rightarrow u$.

5. Side B:(TTM and PTTI respectively)

Line 8: *Dewata Mulia Raya jika merdeka bujang palu.*

Line 9: ***Seratus ratun jika merdeka beristeri.***

Line 10: ***Atawa perempuan bersuami ditanam hinggakan***

Line 11: ***Pinggang dihambalang dengan batu matikan.***

Line 8: *Dewata Mulia Raya jika merdeka bujan palu*

Line 9: ***sa-ratus rautan. Jika merdeka beristeri***

Line 10: ***atawa perempuan bersuami ditanam binggan***

Line 11: ***pinggang di hembalang dengan batu matikan***

Line 8: To repent, the following be done, commandth the Almighty.

Line 9: A hundred whips, **for free man, a wife hath.**

Line 10: **A married woman, to be buried**

Line 11: **To the waist and stoned to death**

Take

p = a wife hath

q = a married woman

r = buried to the waist

s = stoned

t = to death

Thus the above expression is of the form $p \vee q \Rightarrow r \wedge s \wedge t$.

Notice the inconsistency (Lines 8 and 9) in the Malay transcription of TTM and PTTI. The punctuation marks of the one given by TTM are not correctly placed and will mislead the public. The English transcription is also not correct. More inconsistencies have been pointed out in Abdul Razak (2011).

The word **adi** in **adi pertama** (side A) means "the top most" and it is a *hedge*, which is an adverb like "very", "almost", "quite", "slightly" and "more or less", that are used in fuzzy mathematics, to produce new fuzzy sets from a given fuzzy set. For example, "very cold", "almost cold", "quite cold", "slightly cold" and "more or less cold" are fuzzy sets derived from the fuzzy set "cold".

Time

Time is given in terms of day, month and year (date).

Side A

Line 10: *Juma'at di bulan Rejab di tahun sarathan di sasanakala.*

Line 11: *Baginda Rasul Allah telah lalu tujuh ratus dua.*

Line 10: On the noon on Friday in the month of Rejab whilst the sun was in the north by religious reckoning.

Line 11: Seven hundred and two years after the demise of the Holy Prophet.

This is a normal practice in Malay culture when ending a letter, manuscript or inscription. This ending statement is known as *termaktub* (Gallop 1998).

Conclusions

From the above discussion we can conclude that the Terengganu Inscription is a proof indicating that Malay Mathematics, particularly Malay numbers and Malay logic have existed at least before the 14th century.

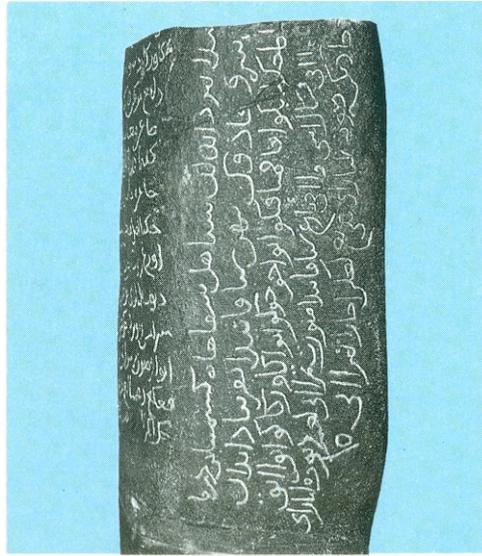
Acknowledgements

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References

- Abdul Razak Salleh. 2002. Unsur matematik dalam persuratan Melayu lama Jawi. *Kesturi*, 12(1 & 2):18-38.
- Abdul Razak Salleh. 2009. Matematik dalam Budaya Melayu. Professorial Inaugural Lecture. Penerbit Universiti Kebangsaan Malaysia, Bangi, Malaysia.
- Abdul Razak Salleh. 2010a. Batu Bersurat Piagam Terengganu Dari Perspektif Matematik. Invited Paper, Seminar Batu Bersurat Terengganu, Muzium Terengganu, 18-19 April.
- Abdul Razak Salleh. 2010b. Batu Bersurat Terengganu: Perspektif Matematik. Paper presented at Seminar on Ethnomathematics, Universitas Riau, Pekanbaru, Sumatera, Indonesia, 18-19 April.
- Abdul Razak Salleh. 2011. Matematik Melayu berdasarkan Batu Bersurat Terengganu. Invited Paper, Seminar Batu Bersurat Terengganu, Muzium Terengganu, 28-29 Mac.
- Al-Attas, Syed Muhammad Naquib. 1970. The Correct Date of the Trengganu Inscription. Muzium Negara Malaysia, Kuala Lumpur, Malaysia.
- Asmah Haji Omar. 1995. Rekonstruksi kata dalam Bahasa Melayu induk. Dewan Bahasa dan Pustaka, Kuala Lumpur, Malaysia.
- Gallop, Annabel Teh. 1994. Warisan Warkah Melayu. The British Library, London, UK.
- Kamus Dewan. 2005. 4th edition. Dewan Bahasa dan Pustaka, Kuala Lumpur, Malaysia.
- Muzium Negeri Terengganu. Memorial Batu Bersurat.
- Othman Mohd. Yatim, Abdul Halim Nasir. 1990. Epigrafi Islam Terawal di Nusantara. Dewan Bahasa dan Pustaka, Kuala Lumpur, Malaysia.
- Shaharir Mohamad Zain. 2000a. Pengenalan Sejarah dan Falsafah Sains. Penerbit Universiti Kebangsaan Malaysia, Bangi, Malaysia.
- Shaharir Mohamad Zain. 2000b. Sistem Angka Melayu Sebelum Kedatangan Islam. *Bulletin of the Malaysian Mathematical Sciences Society (Second Series)*, 23:187-220.
- Shaharir Mohamad Zain, Abdul Razak Salleh. 2001. Sistem Nombor dan Angka Melayu Berdasarkan Kajian Etimologi dan Penyukatan. *Jurnal Bahasa*, 1(3)(September):423-443.
- Wilkinson R.J. 1959. A Malay-English Dictionary (Romanised). Part I (A-K) and Part II (L-Z). McMillan, London, UK.

Appendices.



Side D (Source: Terengganu Museum)

(TTM)

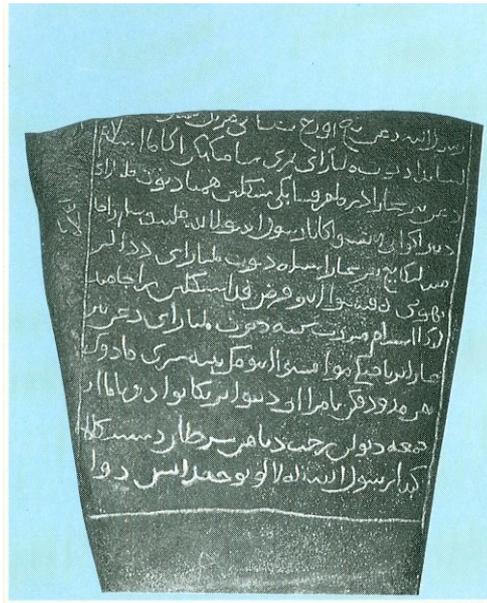
1. ... tiada benar dendanya setahil sepaha kesembilan derma.
2. ... Seri Paduka Tuhan (Tuan) siapa tiada harta dendanya
3. ... Ke sepuluh derma jika anakku atawa pemainku atawa cucuku atawa keluarga ku atawa anak.
4. ... tamra ini segala isi tamra ini barang siapa tiada menurut tamra ini laknat Dewata Mulia Raya.
5. ... di jadikan Dewata Mulia Raya bagi yang langgar acara tamra ini.

(PTTI)

1. ... tida benar dandanya sa-tahil sa-paha. Kesembilan derma.
2. ... Seri Paduka Tuhan siapa tida ... dandanya
3. ... kesepuluh der)ma jika anakku atawa (pemain)(?) ku atawa cucuku atawa keluarku atawa anak.
4. ... tamra ini segala isi tamra ini barang siapa tiada menurut tamra ini laanat Dewata Mulia Raya
5. ... di jadikan Dewata Mulia Raya bagi yang langgar acara tamra ini.

(ET)

1. ... *false evidence, the fine a 'tahil' and a 'paha' Commandment Nine.*
2. ... *Commandth the Almighty, the desolute, pay not the fine*
3. ... *My children, my uncles, my grandchildren and family and their siblings.*
4. *Obey ye this command, for the wrath of God is great.*
5. *Perils and pain awaits those who heed not the Commandment.*



Side A (Source: Terengganu Museum)

(TTM)

1. Rasulallah dengan yang arwah santabi mereka
2. Asa pada Dewata Mulia Raya beri hamba meneguhkan Agama Islam.
3. Dengan benar bicara derma mereka bagi sekalian hamba Dewata Mulia Raya.
4. Di Benuaku ini penentu agama Rasulallah sallallahu wassalama raja.
5. Mandalika yang benar bicara sebelah Dewata Mulia Raya di dalam
6. Bumi penentuan itu fardhu pada sekalian Raja Manda
7. Lika Islam menurut setitah Dewata Mulia Raya dengan benar.
8. Bicara berbajiki benua penentuan itu maka titah Seri Paduka.
9. Tuhan menduduki Tamra ini di Benua Terengganu adi pertama ada.
10. Jumaat di bulan Rajab di tahun saratan disasanakala.
11. Baginda Rasulallah telah lalu tujuh ratus tua.

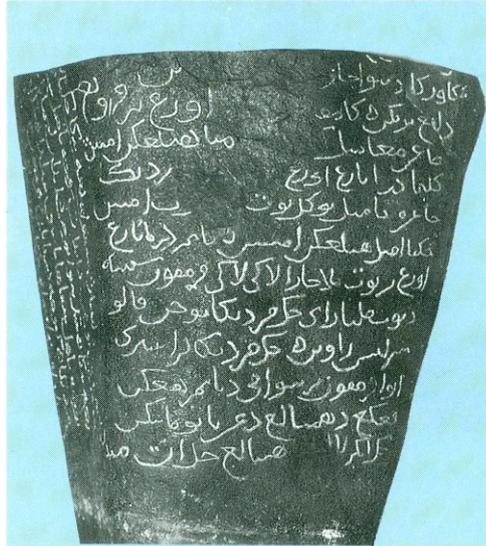
(PTTI)

1. Rasul Allah dengan yang orang ... (bagi) mereka ...
2. ada pada Dewata Mulia Raya beri hamba meneguhkan ugama Islam.
3. dengan benar bicara derma meraksa bagi sakalian hamba dewata Mulia Raya.
4. di benua ku ini (penentu) ugama Rasul Allah sall'illahu 'alaihi wa sallama Raja.
5. mandalika yang benar bicara sebelah Dewata Mulia Raya di dalam.
6. Bebumi. Penentua itu fardzu pada sakalian Raja manda-lika Islam
7. menurut sa-titah Dewata Mulia Raya dengan benar.
8. bicara berbajiki benua penentua itu maka titah Seri Paduka.
9. Tuhan mendudokkan tamra ini di benua Terengganu di pertama ada.
10. Juma'at di bulan Rejab di tahun sarathan di sasanakala.
11. Baginda Rasul Allah telah lalu tujoh ratus dua.

(ET)

1. *Behold the Prophet of God and his apostles.*
2. *Praise the God Almighty for giving us Islam.*
3. *With Islam, truth revealed to all Thy creatures.*
4. *On this land, the religion of the Holy Prophet shall prevail.*
5. *The Holy Prophet, the upholder of truth in Thy kingdom.*
6. *Hear ye kings, these messages.*
7. *Messages from the Almighty. Ye doubt not.*
8. *Goodwill, with thee fellow men, saith the Almighty.*
9. *Be it known, the land of Terengganu, the first to receive messages of Islam.*

10. On the noon on Friday in the month of Rejab whilst the sun was in the north by religious reckoning.
11. Seven hundred and two years after the demise of the Holy Prophet.



Side B (Source: Terengganu Museum)

(TTM)

1. Keluarga di Benua jauhkan
2. (Datang berikan. Keempat orang berpiutang.
3. Jangan mengambil ... (a)mbil hilangkan emas.
4. Kelima derma barang orang ... (mar)dika.
5. Jangan mengambil (tugas buat) temasnya
6. Jika ia ambil hilangkan emas. Keenam derma barang
7. Orang berbuat bala cara laki-laki perempuan satitah.
8. Dewata Mulia Raya jika merdeka bujang palu.
9. Seratus ratun jika merdeka beristeri.
10. Atawa perempuan bersuami ditanam hinggakan
11. Pinggang dihambalang dengan batu matikan.
12. Jika inkar (bala cara) hambalang jika anak Mandalika ...

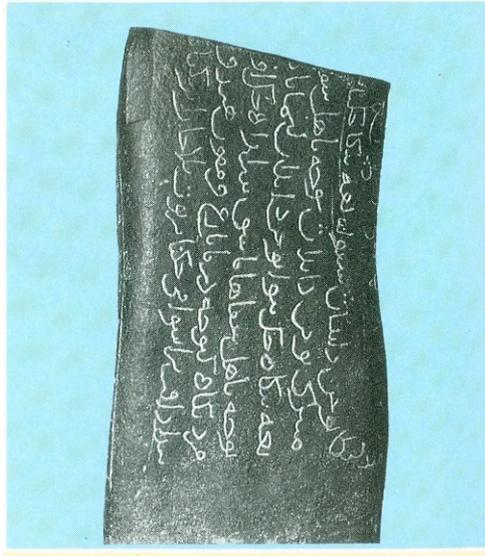
(PTTI)

1. keluarga di benua jauh ... kan ... ul
2. (datang) berikan. Keemp-(at derma barang) orang berpi-hutang
3. jangan mengambil ke ... (a)mbil bilangkan emas
4. kelima derma barang orang ... (mer)deka
5. jangan mengambil (tugal buat) temasnya
6. jika ia ambil bilangkan emas. Keenam derma barang
7. orang berbuat balacara laki-laki perempuan sa-(titah)
8. Dewata Mulia Raya jika merdeka bujan palu
9. sa-ratus rautan. Jika merdeka beristeri
10. atawa perempuan bersuami ditanam binggan
11. pinggang di hambalang dengan batu matikan
12. jika inkar ba(lachara) hambalang jika anak mandalika.

(ET)

1. Brethren of lands distant
2. Cometh hither to tell ye. The Fourth Commandment for debtors.
3. Take ye not, lose ye not, gole in thy hands.
4. Fifth Commandment give thee alms and pay thy lithes.
5. Take thee not, gold of others
6. If taketh thee the gold, return it.

7. *Peril be to adulteres.*
8. *To repent, the following be done, commandth the Almighty.*
9. *A hundred whips, for free man, a wife hath.*
10. *A married woman, to be buried*
11. *To the waist and stoned to death*
12. *Ignore thee not. Be it the daughter of a prophet.*



Side C (Source: Terengganu Museum)

(TTM)

1. Bujang dandanya sepuluh tengah tiga jika ia ...
2. Menteri Bujang dandanya tujuh tahlil se(paha ...
3. Tengah tiga, jika tetua bujang dandanya lima (tahlil ...
4. Tujuh tahlil sepaha masuk bendara. Jika O(rang) ...
5. Merdeka. Ketujuh derma barang perempuan hendak ...
6. Tiada dapat bersuami, jika ia berbuat balabicara ...

(PTTI)

1. bujan dandanya sapuluh tengah (tiga) jika ia ...
2. menteri bujan dandanya tujuh tahlil sa-p(aha ...
3. tengah tiga. Jika (tetua) bujan dandanya lima ta(hil ...
4. tujuh tahlil sa-paha masok bendara. Jika o(rang) ...
5. merdeka. Ketujuh derma barang perempuan hendak ...
6. tida dapat bersuami, jika ia berbuat balachara ...

(ET)

1. *Singles, the fine, ten and a half 'saga'*
2. *A gentry not married, the fine, seven 'tahils' ...*
3. *Two and a half 'saga', the fine for older singles ...*
4. *Seven 'tahils' to the treasury if ...*
5. *Free man. The Seventh Commandment; dowry for woman should ...*
6. *Deny her husband, if she commit adultery.*