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Comparative ethnographical studies.

6
(Part 2.)

CALCULATIONS WITH YEARS AND MONTHS IN THE PERUVIAN QUIPUS

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ELANDERS BOKTRYCKERI AKTIEBOLAG

PREFACE.

Towards the printing of the sixth part of my series of ethnographical studies, dealing exclusively with the Peruvian quipus, I have received from the Royal Hvitfeldtska Stipendie inrättningen a contribution of 1500 kronor, for which I beg to tender my respectful thanks to the trustees. I would especially thank the Lord Lieutenant of the Province of Bohus and Göteborg, Mr Oscar von Sydow, for the interest and insight he has shown in my work.

In this, the second part of Vol. 6, will be found the solution of some Peruvian quipus belonging to the Museum für Völkerkunde in Berlin, and I take the opportunity of thanking Professor Max Schmidt for giving me permission to study them. They constitute but a fraction of the Museum's large collection of quipus. I have taken copies of quipus from the same collection which I shall not be able to deal with on the present occasion.

My principal object in this part of my studies is to publish all the calculations I have found in quipus that have anything to do with the moon, as well as further proofs to show that the figures to be found in the quipus express days, and that the solar year was taken to be 365 days. Additional proofs will be seen in the quipus here published in confirmation of what I have already stated about the number 7 being of great (presumably magical) importance in the calculations of the Indians.

Most of the quipus I deal with in this part are complete, which is a very important matter, since it is very hazardous, in the present circumstances, to attempt to draw conclusions from quipus in which knots are missing.

In the case of one or two conclusions I had drawn in Part I of this series, I am now not quite so convinced of their correctness. The best critique of these results will be obtained continuing to work at the solution of quipus. I am sure that from the day I found that the quipus dealt with astronomical figures I was on the right path, and it is the one I have attempted to follow in this part.

In reading the quipus in Berlin I had the assistance of my wife, the Baroness Olga Nordenskiöld. Our sketches of the quipus were then re-drawn by Miss E. Stenberg. The calculation of one of quipus here reproduced I obtained from Mr Leland Locke, the founder of the modern study of the quipu, and I beg to thank him very sincerely for his kindness, which I have repaid by proving conclusively that this quipu deals with the solar year.

My original intention was to publish the results of my quipu studies in two small volumes, but for several reasons I have decided to spread the material over several volumes, the extent of the whole work depending on the material at my disposal.

Statements of early writers about the calendar of the Peruvian Indians.

Garcilasso de la Vega says that the Incas reckoned the months from new moon to new moon. Furthermore, the Incas reckoned with the solar year, the length of which they determined by observing the summer and winter solstices.[1] [2] If I have understood Garcilasso rightly, the cal-

[1] Libro II. Cap. XXII.

«Para verificar el solstício se ponía vn Inca en cíerto puesto'al salir del Sol y al ponerse; y míraua a ver si salia, y se ponía por entre las dos torres pequeñas, que estaua al oriente y al poníente. Y con este trabajo se certificauan en la Astrologia de sus solstícíos. Pedro de Çieça capitulo nouenta y dos haze mencíon destas torres. El padre Acosta tambíen trata dellas libro sexto capitulo tercero, aunque no les dan su punto. Escriuieron los con letras tan groferas, porque no supíeron fixarlos con los días de los meses en que son los solsticios, porque contaron los meses por lunas como luego diremos, y no por días, y aunque dieron a cada año doze lunas; como el año solar ecceda al año lunar comun en onze dias; no sabiendo ajustar el vn año con el otro, teníau cuenta con el mouímiento del Sol por los Solticíos, para ajustar el año, y contarlo, y no con las lunas: y desta manera díuídían el vn año del otro, rígiendose para sus sembrados por el año solar, y no por el lunar: y aunque aya quien diga que ajustauan el año solar con el año lunar, le engañaron en la relacion, porque si supieran ajustarlos, fixaran los solstícíos en los días de los meses que son, y no tuuíeran necesidad de hazer torres por mojoneras, para mírarlos, y ajustarlos por ellas con tanto trabajo, y cuydado como cada dia tenían, mírando el salír del Sol y el ponerse por derecho de las torres.

Las quales dexé en píe el año de mil y quínientos y sesenta, y si despues aca no las han derríbado, se podria verificar por ellas el lugar, de donde mirauan los Incas los solstícíos, aver si era de vna torre que estaua en la casa del Sol, o de otro lugar; que yo no lo pongo por no estar certificado del.

Tambien alcançaron los equinocíos; y los solenízaron muy mucho. En el de Março segauan los mayzales del Cozco con gran fiesta y regozijo: particularmente el anden de Collcampara, que era como jardín del Sol. En el equínocio de Setiembre hazían vna de las quatro fiestas príncípales del Sol, que llamauan Citua Raymi r. senzilla, quiere dezir fiesta príncipal: celebrauase como en su lugar diremos. Para verificar el equinocio tenían colunas de píedra riquissimamente labradas, puestas en los patios, o plaças que auia ante los templos del Sol, los sacerdotes quado sentian que el equinocio estaua cerca, tenían cuydado de mirar cada día la sombra que la coluna hazia, tenian las colunas puestas en el centro de vn cerco redondo muy grande, que tomaua todo el ancho de la plaça o del patío: por medio del cerco echauan por hilo de oriente a poniẽte vna raya, que por larga esperiencia sabian donde auian de poner el vn punto y el otro. Por la sombra que la coluna hazia sobre la raya, veyan que el equinócío se yua acercando: y quando la sombra tomaua la raya de medio a medio, desde que salia el Sol hasta que se ponia, y que a medio día bañaua la luz del Sol toda la coluna en derredor sin hazer sõbra a parte alguna, dezian q̃ aquel día era el equinocial. Entonces adornauã las colunas con todas las flores, y yeruas olerosas que podia auer, y ponian sobre ellas la silla del Sol, y dezian que aquel dia se asentaua el Sol con toda su luz de lleno en lleno sobre aquellas colunas. Por lo qual en particular adorauan al Sol aquel dia con mayores ostentaciones de fiesta y regozíjo, y le hazian grandes presentes de oro, y plata, y piedras preciosas y otras cosas de estima. Y es de notar que los Reyes Incas y sus Amautas, que eran los philosophos, assi como yuan ganando las prouincias, assi yuan esperimentando que quanto mas se acercauan a la linea equinocíal, tanto menos sombra hazia la coluna al medio dia: por lo qual fueron estímando mas y mas las colunas que estauã mas cerca de la ciudad de Quitu, y sobre todas las otras éstimaron las que pusieron en la misma ciudad, y en su parage hasta la costa de la mar, donde por estar el Sol a plomo (como dizen los albañíes) no hazia señal de sombra alguna a medío dia. Por esta razon las tuuíero en mayor veneracion: porque dezian q̃ aquellas eran assiento mas agradable para el Sol, porque en ellas se assentaua derechamente, y en las otras de lado. Estas simplezas y otras semejantes dixeron aquellas gentes en su Astrología, porque no passaron con la imaginacion mas adelante de lo que veyan materíalmente con los ojos, las colunas de Quitu y de toda aquella region derríbo el gouernador Sebastian de Belalcaçar muy acertadamente, y las hizo pedaços porque ydolatrauan los Yndios en ellas: las demas q̃ por todo el reyno auia, fueron derribando los demas capitanes Españoles como los fueron hallando.»

[2]) Sarmiento p. 67.

«Y para que el tiempo del sembrar y del coger se supiese precisamente y nunca se perdiese, hizo poner en un monte alto al levante del Cuzco cuatro palos, apartados el uno del otro como dos varas de medir, y en culation in months was independent of the calculation in solar years.

Cobo[1]) says that the year was divided up into twelve months. He speaks of the second month when he relates about the festivals, «The first day of the month. . .», and then further down, «The day we saw the new moon that month», and, «six days after the new moon.» The months Cobo speaks of cannot have run from new moon to new moon, as the new moon evidently appeared some days after the beginning of the second month.

Balboa[2]) says that the Incas divided the year into twelve months, the only difference from our division of the year being that theirs began in December. According to Polo de Ondegardo[3]) the year was divided into twelve months, the eleven days by which the solar year exceeded the lunar year being distributed among the various months. According to Velasco[4]) the Incas distinguished between the solar year and the lunar year, the latter being divided into $12^1/_2$

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las cabezas dellos unos agujeros, por donde entrase el sol á manera de reloj ó astrolabio. Y considerando adonde hería el sol por aquellos agujeros al tiempo del barbechar y sembrar, hizo sus señales en el suelo, y puso otros palos en la parte que corresponde al poniente del Cuzco para el tiempo del coger las mieses. Y como tuvo certificados estos palos precisamente, puso para perpetuidad en su lugar unas colunas de piedra de la medida y agujeros de los palos, y á la redonda mandó enlosar el suelo, y en las losas hizo hacer ciertas rayas niveladas conforme á las mudanzas del sol, que entraba por los agujeros de las colunas, de manera que todo era un artificio de reloj anual, por donde se gobernaban para el sembrar y coger. Y diputó personas que tuviesen cuenta con estos relojes y notificasen al pueblo los tiempos y sus diferencias, que aquellos relojes señalasen.»

[1]) Vol. IV, p. 104.

[2]) p. 123.

[3]) p. 123. «El año partieron en doze meses por las lunas: y los demás dias que sobran cada año los consumían en las mismas lunas, y a cada luna, ó mes tenían puesto su mojón ó pilar al derredor del Cuzco donde llegaua el Sol aquel mes.»

[4]) Vol. II, Pt. II, p. 39.

months to make it tally with the solar year. Montesinos[1]) states that the year was divided into twelve months of **30** days, plus five extra days.

The statements about when the year began also vary. The majority of the writers give December, i. e. the year began with the winter solstice. Velasco[2]) says that in Cuzco the lunar month was reckoned from December, and that in Quito both the lunar year and the solar year began in March, at the time of the vernal equinox. According to Fernandez[3]) the year began in June, while Molina[4]) states that it began in May, about the first day the moon appeared. It is not easy to find one's way amid all these contradictory assertions. Yet it seems to me that the statements of different authors about the division of the year into months of unequal lengths can be partly explained in such wise that the solar year and its division into **30** days with **5** extra days had not been adopted everywhere. It was as yet only the system of the learned. The people still reckoned in months that ran from new moon to new moon. It is also possible that in a number of places they reckoned in Pleiad years. Garcilasso[5]) says that of the constellations only the Pleiades were the object of worship. In the Relaciones Geograficas[6]) there is a very valuable description which states that the sun, the moon, Venus, the Pleiades, and other big stars were the objects of worship. Molina says that with the Incas the year began in May. The Pleiad

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[1]) p. 69.

[2]) Tomo II, Parte II p. 39.

[3]) See Jiménez de la Espada, p. 136.

[4]) «y commencaron a contar el año mediado Mayo dias mas ó menos a primero dia de la luna», p. 131.

[5]) Book II, Ch. XXI.

[6]) Rel. Geogr. I, 205, «y por mandado de los Ingas adoraban al sol y á la luna y á los estrellas y en particular al lucero de la mañana que en su lengua le dicen *auquilla*, y las cabrillas, que en su lengua se llaman *larilla*, y a otras estrellas grandes.»

year of the Guarani Indians also began then.[1]) Molina's authorities were not so particular about the day when the year began. Molina says, very characteristically, that they counted the beginning of the year from the middle of May, at about the time of the new moon.

Garcilasso says that the common people reckoned the year from harvest-time.[2])

Montesinos[3]) is the only author who asserted that the Incas were acquainted with the fact that the solar year is really longer than **365** days. He relates that an Inca, Yahuar Huquiz, who was a great astrologer, studied to find out how the intercalary days should be counted every four years. Montesinos' statements, however, must be taken with the greatest caution. He says that another learned Inca introduced a calculation with weeks of **10** days, the last week of the year having **5** days. According to Montesinos, moreover, there were calculations in decades, centuries and chiliads. A chiliad was a sun, five hundred years a half-sun. It is not impossible that a study of the quipus will confirm that the Incas had some calculation with intercalary days.

It cannot be too strongly pointed out that all the more intimate details of the calendar among the Incas, as among the Central American tribes, were only known to the priests, not to the common people. This also explains the superficial acquaintance that the older Spanish authors had with the astronomy of the Peruvian Indians. The medicinemen were those who were least accessible to the whites, and much of their wisdom was never noted down by the Spaniards who described the conceptions of the Peruvian Indians. We must therefore be on our guard against assuming that the Incas did not know more about the movements of the heavenly bodies than we find, for instance, in Garcilasso.

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1) Martin P. Nilsson p. 275 (with literature).

2) Book II, Ch. XXII.

3) P. 69,74.

I have not found in the quipus any trace of a calculation with weeks of 10 days. Besides, a seven days' week is by far the more likely, seeing what an important part the figure **7** plays in the quipus.

Garcilasso[1]) speaks of weeks reckoned by the quarters of the moon. The month would consequently be divided into four weeks.

A division of the year into four seasons is mentioned by Velasco[2]). These seem to have extended from the winter solstice to the vernal equinox, from this to the summer solstice, from this to the autumnal equinox, and lastly from this to the winter solstice.

Of the planets Venus seems to been the especial object of observation and worship.[3]) In the anonymous Jesuit's description of the conceptions of the Incas, attention is called to the great importance they attached to the planets, especially Jupiter. But this anonymous author also offers us the most fantastic statements, such as that Mars was held to be a war god, and Mercury a tutelary god for traders.

Most interesting is Molina's statement[4]) that the Incas

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[1]) Book II, Ch. XXIII. «Contaron los meses por lunas de vna nueua a otra, y assi llaman al mes Quílla tambíen como a la luna, díeron su nombre a cada mes, contaron los medíos meses por la cresciente y menguante della, contarō las semanas por los quartos, aunq̃ no tuuíeron nombres para los días de la semana. Tuuíeron cuenta cō los eclypses del Sol. y de la luna, mas no alcançaron las causas.»

[2]) Velasco, Pt. II, p. 39. «Se distinguian en ambas partes los cuatro tiempos, esto es, primavera ó *panchin*, en el equinoccio hiemal: verano ó *rupay mita*, en junio: otoño ó *uma-raymi*, en el equinoccio autumnal; é invierno ó *tamia-mita*, en diciembre. En cada uno de estos 4 tiempos se celebraba una solemnísima fiesta principal, de las cuatro que tenia el año, precediendo el ayuno general llamado *zazi puncha*, y siguiéndose los sacrificios, los banquetes, música y bailes.»

[3]) Garcilasso de la Vega, Book II, Ch. XXI.; Rel. Geogr. I, p. 205.

[4]) P. 125.

«no obstante que ussavan de una quenta muy subtil de unas ebras de lana de dos ñudos y puesta lana de colores en los ñudos los quales used quipus to keep an account of their calculations in years and months. I reproduce here the quotation from Molina, as in the English version published by Locke it is somewhat garbled. He omits the last, important lines, which point out that the Inca Yupanqui introduced the calculation with winters and summers, but that formerly quipus were used for keeping count of years and months.

In this connection we must remember that the primitive quipus used in Guiana were *exclusively* for counting days. When, as Gumilla[1]) relates, two Indians were to meet after a certan number of days, they made as many knots on a cord as corresponded to the intervening days. Every day they undid a knot, by which means they made sure of keeping the appointment.

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llaman *quipos* entendianse y entiendense tanto por esta quenta que dan razon de mas de quinientos años de todas las cossas que en esta tierra en este tiempo an passado: tenian yndios yndustriados y maestros de los dichos *quipos* y quentas y estos yban de generacion en generacion mostrando lo pasado y empapandolo en la memoria a los que avian de entrar, que por maravilla se olividaban cosa por pequeña que fuese tenian en estos *quipos* que cassi son a modo de pavilos con que las biejas reçan en nuestra España salvo ser ramales tenian tanta quenta en los años messes y luna detal suerte que no avia lunar, luna, año ni mes aunque no con tanta pulicia como despues que *Ynga Yupanqui* empeço a señorear y conquistar esta tierra; porque hasta entonces los yngas no avian salido de los alrededores del *Cuzco*. Como por la relacion que V.ª S.ª Rma. tiene, parece este ynga fue el primero que empeço a poner quenta y razon en todos las cossas y el que quito cultos y discultos y cerimonias que en cada uno dellos hacen, porque no obstante que antes que reynasen sus antecesores, tenian meses y años por sus *quipos*, no se regian con tanto concierto como despues que este fue señor que se regian por los ynviernos y veranos.»

[1]) Tomo II, P. 323.

Description of the Quipus.

Quipu 9. (Plate 6).

Museum für Völkerkunde, Berlin, V. A. 16636. This quipu is fastened to a beautifully carved wooden beam. It is from Nasca.

The quipu consists of a brown main cord, to which are attached **180** H-cords[1]) (main cords), divided into **20** groups with **9** strands in each group. The B-cords (secondary cords) are **10** in number. A couple of these are damaged, but it is not likely that they were provided with knots.

The numbers on the cords run as follows:

H-cords in each group, from I to IX.

Group	I	II	III	IV	V	VI	VII	VIII	IX	B-cords	Total
I	3	13	8	22	12	14	10	4	96	0	182
II	15	15	20	10	22	7	17	4	91	x	201 x=0
III	16	13	20	19	29	18	30	3	95	2	245
IV	20	25	20	15	11	15	11	2	90	x	209 x=0
V	34	32	23	23	12	25	18	7	98	1	273
VI	32	36	26	26	10	15	23	9	79	0	256
VII	9	10	16	18	11	6	14	2	93	1	180
VIII	22	18	14	36	10	5	17	2	93	1	218
IX	30	41	15	45	16	18	30	11	98	1	305
X	31	23	28	43	35	3	18	22	96	1	300
XI	35	69	20	30	31	24	23	10	114		356
XII	25	61	11	16	17	16	22	6	63		237
XIII	16	32	12	21	16	20	11	6	53		187
XIV	5	6	10	18	6	12	6	4	34		101
XV	21	21	12	24	25	19	11	8	53		194
XVI	11	27	3	28	18	22	10	8	75		202
XVII	12	12	11	18	20	11	11	7	56		158
XVIII	14	37	13	20	23	18	17	8	70		220
XIX	4	16	4	21	11	5	13	4	45		123
XX	8	11	9	15	13	14	7	4	28		109
Total	=4249=607×7									7	4256=7×608

[1]) See Part I, p. 5.

As half the quipu hangs on one side of the wooden beam, and half on the other, cord I on group X hangs against cord I on group XI. The result is that in the schematic drawing groups I to IX begin with cord I, groups XI to XX with cord IX.

It can be seen from the drawing that cords VI and VII are completely or partly bicoloured. All the other H-cords are one-coloured in light brown or brown. The B-cords are dark brown.

The sum of the numbers on the brown H-cords is	**1595**
» » » » » light brown »	**2048**
Total	**3643**
» » » » » B-cords on these is	**7**
» » » » » all the brown (one-coloured) cords with B-cords is	**3650** (**10**×**365**)

i. e. 10 years, presuming, as I have done in Part I, that all the numbers indicate days.

The sum of the numbers on the green and light brown (bicoloured) H-cords is......	**134**	
Do. on the dark brown and light brown (bicoloured) H-cords	**472**	(**16**×**29.5**)
	606	

Note that the sum of the numbers on the bicoloured dark brown and light brown cords is **472**, which is **16**×**29.5**. In the following pages we shall find that multiples of **29.5** play a much greater part in the quipus than can be accounted for by mere chance. **29.5** is almost exactly the time of the synodical revolution of the moon, the exact time being **29.53**; and it is not unnatural to assume that the Indians calculated it to be $29^1/_2$ days.

Note also that the sum of the numbers in the first (last?) group is **182**, or as near half a solar year as can be expressed in whole numbers. Quipu 11 begins (ends) with a number divisible by **365**. Compare also Quipu 13, in which the sum of the numbers on the three last (or first) cords is divisible by **365** without a remainder. I have written »first or last» because we do not yet know which is the beginning and which the end of these quipus.

Remark that the sum of the numbers on all the one-coloured H cords is **3643**

Remark that the sum of the numbers on all the bicoloured H cords is **606**

Total **4249=144×29.5+1**

i. e. **144** synodical months + **1** day

The sum of the numbers on the green and light brown (bicoloured) H cords is **134**

The sum of the oumbers on the brown (one-coloured) H cords is **3643**

Total **3777=128×29.5+1**

The sum of the numbers on the light brown H cords is **2048**

The sum of the numbers on the B ords (dark brown) is................. **7**

The sum of the numbers on the green and light green is (bicoloure) H cords is **134**

Total **2189=6×365—1**

The sum of the numbers on the brown H cords is **1595**

The sum of the numbers on the dark brown and light brown (bicoloured) H cords is **472**

Total **2067=70×29,5+2**

The above explains that the number **3643** is composed of **2048** and **1595**, also that **606** consists of **134** plus **472**, which numbers were obtained by using cords of different colours.

The sum of the numbers in the whole quipu is 4256. This number is divided into 20 groups. Two of these are divisible by 30, viz. 180 and 300. The sum of these is 480, i. e. 16 ×30, or 16 months of 30 days.

The sum of the numbers in the remaining groups is 3776, which is 128 ×29.5, or 128 months of $29^{1}/_{2}$ days.

4256 is consequently 16 ×30 + 128 ×29.5. This is an interesting division of the sum of all the numbers in the quipu into 16 months of 30 days and 128 months of $29^{1}/_{2}$ days. The division was effected by distributing the numbers in groups. Should similar combinations occur in other quipus, it can hardly be accidental.

From this quipu we learn that the Peruvian Indians reckoned with months of $29^{1}/_{2}$ days. The quipu also affords corroboration of their having counted the solar year as consisting of 365 days.

There is a good deal in this quipu that I have been unable to interpret. Everything in the quipus appears to have some significance. We might, for instance, note that the numbers on cord IX are always greater than the numbers on the other cords in the same group. On one side of the wooden beam these cords have secondary cords. The sum of the numbers on these H-cords with B-cords is 929. The sum of the numbers on the B-cords is 7. 929 + 7 = 936 = 18 ×52. This number, 52, reappears in almost every quipu; in Mexico it played a very great part. What could it signify here?

Quipu 10. (Plate 6).

Museum für Völkerkunde, Berlin. V. A. 47081. It is from Ica. The main cord in this complete quipu is white and brown. On it are 108 H-cords and 13 B-cords There is no evident division into groups.

A peculiarity of this, as of some other quipus, is that long knots and ordinary overhand knots are used in the second row from the bottom, i. e. in the row of knots that we should count as tens. If we read this quipu in such a way that we assume all the knots in the lowest row to be units and all the knots in the upper row, irrespective of whether they are overhand knots or long knots, to be tens, we get the following result:

The sum of the numbers	on the H-cords	on the B-cords
white	**2418**	
light brown	**1068**	
dark brown	**162**	
grayish brown (on light brown)		**20**
» » (» dark brown)		**1**
dark brown and white (on white)		**40**
Total	**3648**	**61**

Thus we see that the sum of the numbers on all the H-cords is **3648**, or $10 \times \underline{365} - 2$. This, it will be observed, very closely approximates to **10** solar years.[1])

The sum of the numbers on the B-cords is **61**. $61 + 3648 = 3709 = 32 \times \underline{116} - 3$. **116** is about the synodical revolution of Mercury.

The sum of the numbers on the white H-cords is **2418** $= 82 \times \underline{29.5} - 1$, i. e. **82** months — **1** day.

The sum of the numbers on all the brown H-cords is $1230 = 41 \times \underline{30}$, i. e. **41** months of **30** days.

$$3648 = 10 \times \underline{365} - 2 = 82 \times \underline{29.5} - 1 + 41 \times \underline{30}.$$

Here there is a similar division to the one in the foregoing quipu, i. e. in months of **30** and **29.5** days. This has

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[1]) Note that the sum of the numbers on all the one-coloured brown cords in Quipu 9 is $3650 = 10 \times 365$

The sum of the numbers on all the H-cords here is $3648 = 10 \times 365 - 2$

The sum of all the cords in Quipu 8 is $3654 = 10 \times 365 + 4$

There may therefore be some truth in MONTESINOS' assertion that the Incas reckoned in decades.

been done by putting the numbers for the synodical months on white cords, and those for the months of **30** days on brown cords.

Let us now read this quipu in another way, assuming the eights as usual to be ones, and all long knots to be unit knots. The overhand knots, which are all in the second row from the bottom, we will as usual assume to be tens. We then get:

	H-cords	B-cords
The sum of the numbers on the white......	357	
light brown	240	
dark brown	27	
grayish brown (on light brown)		20
» » (on dark brown)		1
dark brown and white (on white)		4
	624	25
Total	649	

The sum of the numbers on all the H-cords is $624 = 12 \times \underline{52}$

» » » » » » » » H & B-cords is $649 = 22 \times \underline{29.5}$

i. e. **22** synodical months.

It is possible that **624** consists of months of **30** days and $29^1/_2$ days. The sum of the numbers on the light brown H-cords is $240 = 8 \times \overline{30}$, and the sum of the numbers on the remaining H-cords is $384 = 13 \times \underline{29.5} + 0.5$.

Presumably both readings are correct, whether the knots be taken as they are placed or not. This may constitute the real puzzle of this quipu.

The slight errors to be found in the quipu, e. g. that the sum of the numbers on the H-cords, according to the first interpretation, is **3648** instead of **3650**, may be explained, in my opinion, by the desire to arrive at astronomical numbers in as many combinations as possible. This could probably not have been done if the sum of the numbers on the H-cords (read as placed) had been raised to **3650**. A slight reduction was required to make the other calculations fit in.

In this quipu, as I have attempted to explain, the solar year was reckoned at **365** days (with an error of two days in ten years), and the months at $29^1/_2$ days and **30** days.

With the other interpretation (not read as placed), the sum of the H-cords is divisible by **52**, a number that occurs so frequently in the quipus that it must have been used intentionally.

Quipu 11. (Plate 7,)

Museum für Völkerkunde, Berlin. V. A. 42527. It is from Pachacamac.

The main cord is brown and white. On it hang $21 = 3 \times 7$ white H-cords, divided into **4** groups. There are no B-cords.

It is to be observed that higher figures occur on this quipu than on any quipu hitherto described. The highest number on a cord is **37076**.

The numbers on the H-cords are:

$3285 = 9 \times 365 = 9$ years.

34167

$35577 = 1206 \times 29.5 = 1206$ months

25419

$37076 = 713 \times 52$

$20119 = 682 \times 29.5 = 682$ months

$18379 = 623 \times 29.5 + 0.5 = 623$ months $+ ^1/_2$ day

$2007 = 5 \times 365 + 182 = 5^1/_2$ solar years $- ^1/_2$ day $=$
$68 \times 29.5 + 1$

$2080 = 40 \times 52 = 8 \times 260$

$3102 = 8 \times 365 + 182 = 8^1/_2$ solar years $- ^1/_2$ day.

2247

2578
2016
3419
3159
1407
2178

$$\left.\begin{array}{r}2085\\2329\\1385\\1501\end{array}\right\} = 7300 = 20 \times \underline{365} = 20 \text{ years}$$

Total **205515** $= 563 \times \underline{365} + 20$, i. e. **563** years + **20** days.

Note that the figures in **563** are those in **365** reversed. This may be a mere chance.

Is the **20** a miscalculation or an intentional error? **205515** $= 5 \times 3 \times 3 \times 4567$ (primary number).

It can hardly be a mere chance that of the **21** (3×7) numbers in this quipu one is divisible by $\underline{365}$, **2** by $\underline{29.5}$ without a remainder, **1** by $\underline{29.5}$ with a remainer of **0.5**, **2** by $\underline{365}$ with a remainder of **182**, which is half a year, and that furthermore the sum of the four last numbers is divisible by **365**.

Two numbers, as can be seen, are divisible by $\underline{52}$, one of them = 8×260.

The number **7** plays an important part in this quipu.

Group I

$$\left.\begin{array}{l}
3285 = 5 \times 657 \quad (657 = 5 \times 3 \times 3 \times 73) \\
\left.\begin{array}{l}
34167 = 3 \times \overline{7} \times 1627 \quad (\text{prime number}) \\
35577 = 59 \times \overline{3} \times 3 \times \overline{67} \\
25419 = 3 \times 229 \times 37 \\
37076 = 2 \times 2 \times 13 \times \overline{31} \times 23 \\
20119 = 59 \times 11 \times 31 \\
18379 = \text{prime number}
\end{array}\right\} \begin{array}{l}170737 = \\ \overline{7} \times 24391 \\ (\text{prime} \\ \text{number})\end{array}
\end{array}\right\} \begin{array}{l}174022 = \\ 2 \times 87011 \\ (\text{prime} \\ \text{number})\end{array}$$

Group II

2007=223 ×3 ×3
2080=2 ×2 ×2 ×5 ×2 ×2 ×13
3102=2 ×3 ×11 ×47
2247=3 ×7 ×107

9436=2 ×2 ×7 ×337 (prime number)

Group III

2578=2 ×1289 (prime number)
2016=2 ×2 ×2 ×2 ×2 ×9 ×7
3419=13 ×263
3159=3 ×3 ×3 ×117
1407=3 ×7 ×67

12579=1797 ×7 (1797=3 ×599)

Group IV.

2178=2 ×3 ×3 ×11 ×11
2085=5 ×417 (417=3 ×139)
2329=17 ×137
1385=5 ×277
1501=19 ×79

9478=2 ×7 ×677 (prime number)

It is noticeable that the sum of the numbers in three out of the four groups is divisible by 7, and the sum of all the five-figure numbers is divisible by 7. Of the five-figure numbers there are two not divisible by 365, 29.5, or 52, or by 29.5 with a remainder of 0.5. These two are 34167=3×7 ×1627, and 25419=3 ×229 ×37. They are consequently divisible by 7 or by a number whose last figure is 7.

The sum of the last four numbers is 7300=20 ×365. These numbers are 2085=5 ×417 (417=3 ×139).

2329=17×137 (prime number).
1385= 5×277 (prime number).
1501=19× 79 (prime number).

It may appear curious that the Indians should have reckoned with such high numbers as in this quipu, but we must remember that counting with quipus must have been very easy owing to the clear disposition of the numbers, which had a value according to their position. If we lay out a quipu so that all the units lie properly in place, and all the tens, etc., it is almost as easy to add and subtract with a quipu as working with Arabic characters on a piece of paper. We may be sure that an Indian did not have to have to sit long fingering the knots in order to discover their value; his eye would certainly be able at a glance to distinguish between a **5**-knot and a **6**-knot, etc.

Quipu 12. (Plate 6).

Museum für Völkerkunde, Berlin. V. A. 47078. It is from Ica. The main strand is light brown. On this are **43** H-cords with **28** B-cords, divided into **4** groups.

Group I.

Numbers on	H cords	B cords	Total
	0	80	80
	110	96	206
	394 = 2 × 197	8	402 = 6 × 67
	78	10	88
	210 = 30 × 7	37	247 = 247
	200	50	250
	324 = 11 × 29.5 — 0.5	0	324 = 4 × 3 × 27
	222 = 6 × 37	0	222 = 6 × 37
	237	23	260 = 5 × 52
	222 = 6 × 37	34	256
	684 = 4 × 3 × 57	20	704
	485 = 5 × 97	54	539 = 7 × 77
Total	3166	412	3578 = 9 × 397 + 5

Group II.

Numbers on	H cords	B cords	Total
	20	15	35=5 ×7
	53	10	63=9 ×7
	47	11	58
	73	12	85=5 ×17
	18	36	54=2 ×27
	52	44	96
	20	33	53
	42=6 ×7	50	92
	26	22	48
	60	34=2 ×17	94=2 ×47
	63=9 ×7	12	75
	271	80	351=3 ×117
Total	745	359	1104=3 ×365+9

Group III.

In this group there are no B cords

Numbers on H cords	
324	=12 × 27
162	= 6 × 27
381	= 3 ×127
163	
261	= 3 × 87
296=10 ×29,5+1	= 8 × 37
397	= 397
292	= 4 × 73
373	
324	=12 × 27
850	=50 × 17
828	= 4 ×207
4651 (prime number)	

Group IV.

Numbers on	H cords	B cords	Total
	1378	2067	3445
	75	31	106
	428	205	633
	27		27
	144	300	444
	3561		3561
	1104		1104
Total	6717	2603	9320

The whole quipu

The sum of the numbers	H cords	B cords	Total
on dark brown	5733	2900	8633
light brown	7481[1]	244	7725[1]
white	2065 ($=70 \times 29{,}5$)	230	2295

The sum of the numbers in the groups:

	H cords	B cords	Total
group I	3166	412	3578
» II	745	359	1104
» III	4651		4651
» IV	6717	2603	9320
	15279	3374	18653

Thus we see that the sum of the numbers in this quipu is 18653. This equals $47 \times 397 - 6$, possibly referring to synodical revolution of Jupiter, which is nearly 398 days. The sum of the numbers on the cords in Group I is $3578 = 9 \times 397 + 5$. The number on cord III in Group III is 397. In Part I is published a quipu (4) in which the sum of the numbers on all the cords is 2777. $2777 = 7 \times 397 - 2$. In this last case the remainder 2 is easily accounted for, since it

[1] Note. $7725 = 20 \times 29.5 + 5 \times 365$
$7481 = 20 \times 365 + 181$ nearly $20^1/_2$ years.

appears from the whole quipu that numbers were aimed at in which **7** plays as great a part as possible.[1])

In this quipu there are three numbers, **210**, **60** and **300**, which are divisible by **30**. The sum of these is **570**. The sum of the other numbers on the cords is **18083**$=$**613** $\times$**29,5** —**0,5**.

18653 is consequently **19** $\times$**30**$+$**613** $\times$**29.5**—**0,5**$=$**47** $\times$ **397**—**6**.

Quipu. 13. (Fig. 6.)

This quipu is depicted in Locke's book, Pl. XV. It is from Chancay. It has **12** H-cords bound together in a curious way (see Fig. 6). Locke has sent me the following statement of the value of the knots:

Transcript of Notes on Quipu B 8711 Plate XV.

Left to right

Main strand white loop tied in **4** loops

Strands	100 s	10 s	1 s	Colour
I	10	2	7	brown
I	2	1	0	white and light blue
II	6	1	4	brown
III	8	3	0	golden brown
IV	6	1	4	light brown
I	1	1	7	white
II	1	1	7	blue
III	1	1	7	light brown
IV	1	2	4	» »
V	1	2	3	» »

[1]) In Quipu 4 the sum on the H-cords is 1917, which$=65\times 29.5$— 0.5. The sum on the B-cords is 860.

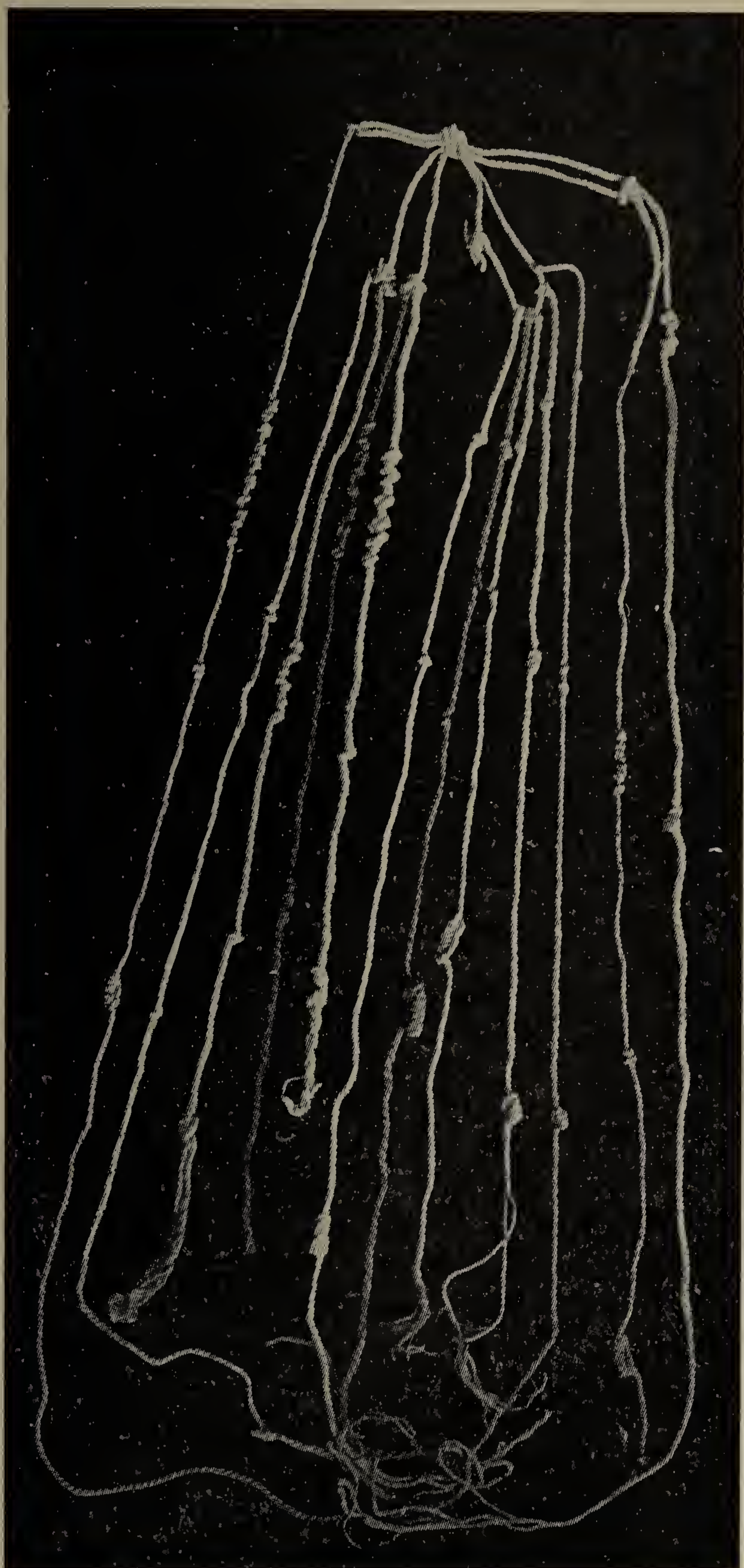

Fig. 6. Quipu from Chancay. After Locke.

I	6	2	8	white and light blue
II	2	2	0	white (large)

Assuming all the numbers to be days, and turning them into years of **365** days, we get:

		years	days
1027	=	2	297
210	=	0	210
614	=	1	249
830	=	2	100
614	=	1	249
117	=	0	117
117	=	0	117
117	=	0	117
124	=	0	124
123	=	0	123
628	=	1	263
220	=	0	220
4741			

3646=**10** years—**4** days.
731=**2** years+**1** day.

364=**1** year—**1** day.
1095=**3** ×**365**=**3** years.

The sum of all the numbers in this quipu is **4741**=**13** × **365**—**4**. It is **13** years less **4** days.

It should be noted that the day on which the eighth cord ends is the same day (apart from the correction) as the one on which the twelfth cord ends. The same day that ends the seventh cord, ends the tenth to within one day. The day that ends the fourth cord recurs to within one day on the sixth cord. This shows that the quipu deals with certain recurring days. Possibly festivals?

By dividing the numbers on the cords into such as contain even tens and such as do not, we obtain this result:

210	1027
	614
220	614
	117
830	117

$1260 = 42 \times \underline{30}$, i. e. 42 months of 30 days.

$$\begin{array}{r} 117 \\ 124 \\ 123 \\ 628 \\ \hline 3481 \end{array}$$

$3481 = 118 \times \underline{29.5}$, i. e. 118 months of 29.5 days. $118 = 4 \times 29.5$.

This shows that $13 \times \underline{365} - 4 = 42 \times \underline{30} + 118 \times \underline{29.5}$. So we see in this quipu, too, that the numbers have been distributed among cords of various colours in such a way that, if we take the numbers on certain colours together, we get a number divisible by 30, whereas the numbers on the other cords give us a total divisible by 29.5.

The sum of all the number in this quipu, as I have pointed out, is $4741 = 13 \times \underline{365} - 4$. There is the possibility of a knot having come away on the fourth cord.[1]) If this had the value 4, the sum of all the numbers in the quipu world be $4745 = 13 \times \underline{365}$, but this would invalidate the division into months of 30 days and 29.5 days, which seem to be present in this quipu. I would assume, presuming such a knot ever existed, that it was removed before the quipu was deposited in the grave. This is not the only quipu in which a unit knot is lacking, and I suspect that there was some «correcting» of the quipus in certain cases. See, for instance, Quipu 2 in Part I.

[1]) On this point Mr Locke writes:

I have carefully examined again Quipu XV, concerning which you ask in yours of May 25.

Two of the strands have end knots. Several have butt ends, that is the several strands of the cord are backlaced or tied to form an end which will not untwist. All of the others are untwisted more or less, some of them back as far as the unit's knot, except that the fourth from the left is broken off abruptly. This strand is very dark brown and is the only one that shows signs of disintegration due to the dye. Unquestionably a part of this strand is missing. I have had an interest in this specimen from the first from the peculiar looping of the main cord.

L. Leland Locke.

Quipu 14. (Plate 7.)

Museum für Völkerkunde, Berlin. V. A. 42550. It is from Pachacamac.

This is a very small, complete quipu, entirely white. It consists of **34** (**2** $\times$ **17**) cords, **18** of which are H-cords and **16** B-cords. There is no number in it above **5**.

The sum of the numbers on the H-cords is **61**
» » » » » » » B- » » **59** (**2** $\times$ **29.5**; 2 months)
Total **120**

If we are correct in assuming that the Indians divided the year up into **12** months of **30** days plus **5** days, **120** can mean **4** months. The division of **120** into **59** and **61** may mean **2** months of $29^1/_2$ days plus **2** months of $30^1/_2$ days $=$ **4** months of **30** days.

Quipu 15. (Plate 7.)

Museum für Völkerkunde, Berlin. V. A. 42584. It is from Pachacamac.

This small, complete quipu consists of a brown and white main cord and **9** H-cords united in a group. There are no B-cords. All the cords with knots are white.

The numbers on the H-cords are

$168 = 24 \times 7$
$133 = 19 \times 7$
$224 = 32 \times 7$
$227 = 227$ prime number
$82 = 2 \times 41$
$168 = 24 \times 7$
$194 = 2 \times 97$
$79 =$ prime number
Total $1275 = 5 \times 5 \times 3 \times 17$

1275 is $3 \times 365 + 6 \times 30$, i. e. **3** years and **6** months of **30** days.

1275 is also $11 \times \underline{116} - 1$, nearly **116** days being the synodical revolution of Mercury.

Note once more the important part played by **7** in the quipu. Only two numbers in it are divisible by **3**, and none by **5**.

Quipu 16. (Plate 7.)

Museum für Völkerkunde, Berlin. V. A. 47097. It is from Ica.

This quipu consists of a white and brown main cord with **12** H-cords distributed on two groups with **6** cords in each group. In the first group there are **6** B-cords, in the other **3**. The number of H and B cords is consequently **22**.

One of the H-cords has two B-cords, one of which is quite short. But as it is provided with an end knot, it is not defective. The quipu is complete.

Group I.

Numbers on	H cords	B cords	
	$14 = (2 \times \underline{7})$	1	$\left.\right\} = \underline{30}$ (first two rows)
	$14 = (2 \times \underline{7})$	1	
	$21 = (3 \times \underline{7})$	1	
	26	4	
	$28 = (4 \times \underline{7})$	7	
	$63 = (9 \times \underline{7})$	8	
Total	166	+ 22	$= 188 = 4 \times \underline{47}$

Group II.

Numbers on	H cords	B cords
	0	1
	0	
	12	
	15	
	33	30
	65	51
Total	125	+ 82

$= \underline{365}$

Total $125 + 82 = 20\underline{7} = \underline{7} \times \underline{29,5} + 0,5$,

$\underline{7}$ months $+ \frac{1}{2}$ day.

The sum of the numbers on all the H cords is $291 = 3 \times \underline{97}$

The sum of the numbers on all the B cords is $104 = 2 \times \underline{52}$

The sum of the numbers on all the white cords is $291 = 3 \times \underline{97}$

The sum of the numbers on all reddish brown cords is $102 = 6 \times \underline{17}$

The sum of the numbers on all yellow brown cords is **2**

The sum of the numbers on the cords in the whole quipu is **395.**

$395 = \underline{365} + \underline{30}$ i. e. **1** year and **1** month. **395** is also $= \underline{397} - 2$.

This quipu shows some resemblances with the foregoing one.

$\underline{7}$ again plays an important part.

Note that here the sum of the numbers on the B-cords is $104 = 2 \times \underline{52}$.

The sum of all the numbers in Quipu 15 is $1275 = 3 \times \underline{365} + 6 \times \underline{30} = 11 \times \underline{116} - 1$

The sum of all the numbers in Quipu 16 is $395 = 1 \times \underline{365} + 1 \times \underline{30} = \underline{397} - 2$

An attempt may possibly have been made to express the apparent revolutions of Mercury and Jupiter as nearly as possible in solar years and months.

Astronomical Numbers in the Quipus.

QUIPU 9.

The sum of the numbers in the whole quipu is $4256 = 16 \times \underline{30} + 128 \times \underline{29.5}$

on all the brown (one-coloured) H cords and their B cords: $3650 = 10 \times \underline{365}$

on the darkbrown and light brown (bicoloured) H cords: $472 = 16 \times \underline{29.5}$

on all the H cords: $4249 = 144 \times \underline{29.5} + 1$

on the light brown H cords and their B cords, the numbers on the green and light green (bicoloured) H cords: $2189 = 6 \times \underline{365} - 1$

on the brown H cords and the dark brown and light brown (bicoloured) H cords: $2067 = 70 \times \underline{29.5} + 2$

QUIPU 10.

The numbers have value according to position.

The sum of the numbers on all H cords is $3648 = 10 \times \underline{365} - 2$

The sum of the numbers on all H cords and B cords is $3709 = 32 \times \underline{116} - 3$

The sum of the numbers on the white H cords is $2418 = 82 \times \underline{29.5} - 1$

The sum of the numbers on the brown H cords is $1230 = 41 \times \underline{30}$

Numbers not counted according to position.

The sum of the numbers on all H cords is $624 = 12 \times \underline{52}$

» » » » » in the whole quipu is $649 = 22 \times \underline{29.5}$

on all the light brown cords: $240 = 8 \times \underline{30}$

on the white and the dark brown cords $384 = 13 \times \underline{29.5} + 0.5$

$624 = 8 \times 30 + 13 \times 29.5 - 0.5.$

QUIPU 11.

Number on cord I $3285 = 9 \times \underline{365}$

» » » III $35577 = 1206 \times \underline{29.5}$

Number on cord V $37076 = 713 \times \underline{52}$
» » » VI $20119 = 682 \times \underline{29.5}$
» » » VII $18379 = 623 \times \underline{29.5} + 0.5$
» » » VIII $2007 = 5 \times \underline{365} + 182 = 68 \times \underline{29.5} + 1$
» » » IX $2080 = 40 \times \underline{52}$
» » » X $3102 = 8 \times \underline{365} + 182$

The sum of the numbers
on cord XVIII—XXI $7300 = 20 \times \underline{365}$

QUIPU 12.

The sum of the numbers in
group I $3578 = 9 \times \underline{397} + 5$
in » II $1104 = 3 \times \underline{365} + 9$
» the whole quipu $18653 = 47 \times \underline{397} - 6$
on all the white H cords $2065 = 70 \times \underline{29.5}$

QUIPU 13.

The sum of all the numbers in the
quipu is $4741 = 13 \times \underline{365} - 4$
» » » the numbers of the four last
(first?) cords $1095 = 3 \times \underline{365}$
» » » » » on white and
light blue, white
(large) and gol-
dens brown
cords $1260 = 42 \times \underline{30}$
» » » » » on the other
cords $3481 = 118 \times \underline{29.5}$

QUIPU 14.

The sum of the numbers in the whole quipu is $120 = 4 \times \underline{30}$
» » » » » on B cords $59 = 2 \times \underline{29.5}$

QUIPU 15.

The sum of the numbers
in the whole quipu is $\mathbf{1275 = 3 \times \underline{365} + 6 \times \underline{30} = 11 \times \underline{116} - 1}$

QUIPU 16.

The sum of the numbers in the whole

	quipu is	$\mathbf{395 = \underline{365} + \underline{30}}$
» » » » »	on the B cords	$\mathbf{104 = 2 \times \underline{52}}$
» » » » »	in group II	$\mathbf{207 = 7 \times \underline{29.5} - 0.5}$

I assume that the results I have hitherto arrived at suffice to prove that the Indians reckoned with solar years of **365** days, and with months of either **29.5** days or **30** days. The importance of the number **7** has been clearly shown. That the Incas reckoned both with synodical months and with a division of the year into **12** months of **30** days plus **5** extra days, also seems to follow from what the oldest writers say. The quipus thus support their statements.

From my results it also seems to follow that the Indians in Peru knew about and reckoned with the synodical revolution of Jupiter, which they calculated at **397** days. In the quipus I have been dealing with there are also combinations of numbers which make it probable that the Indians knew the synodical revolution of Mercury, which they calculated at **116** days. (See Part I).

From the material that I have examined so far I conclude that the quipus found in the Peruvian graves are just clever combinations of astronomical numbers, and of the number $\underline{7}$, or of numbers that presumably had a magic importance for the Indian astronomers, or, more precisely, the Indian astrologers. That it was just this type of quipu which was deposited in the graves, must show that they were of some importance to the dead.

Our study of the quipus is still in its infancy. The quipus that exist in various museums must be published, and, above all, quipus that may still be discovered in Peru must be provided with a careful statement of the conditions of the find. We know absolutely nothing about the other objects with which quipus have been discovered; the quipus may have come from graves of medicine-men.

It goes without saying that it invests the study of the quipus with far greater interest now that we know that in them are preserved the astronomical knowledge of the Peruvian Indians than if they only contained accounts, or the like, the importance of which we should probably never have been able to interpret.

In the next Part of this series I hope to present some fresh material.

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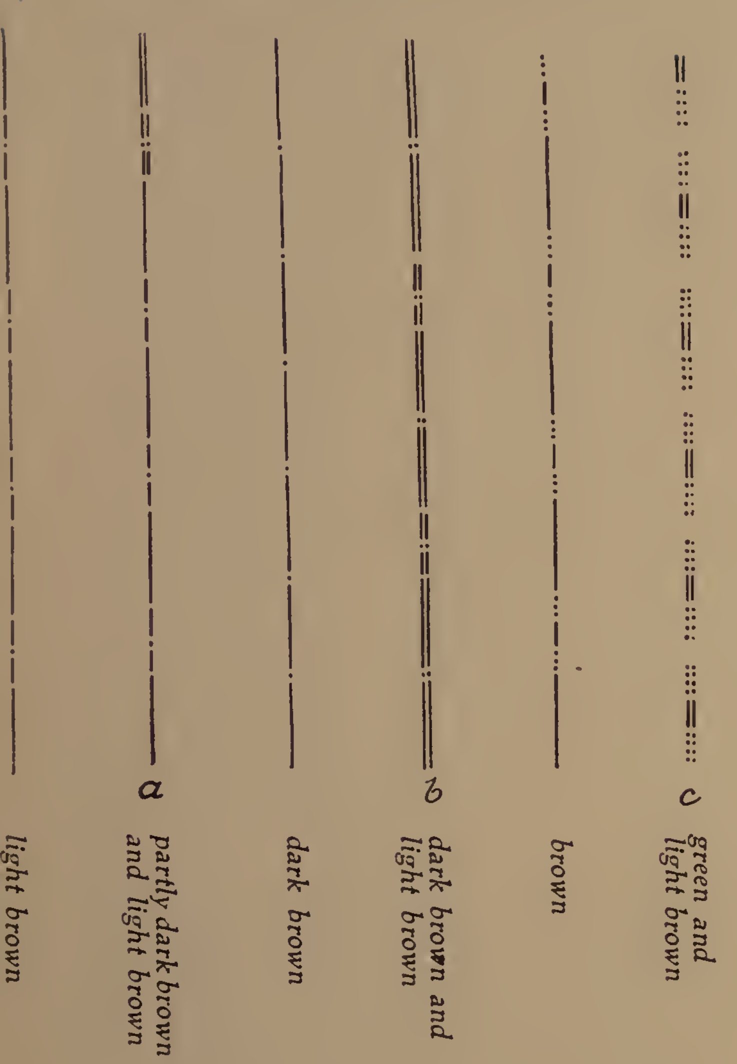
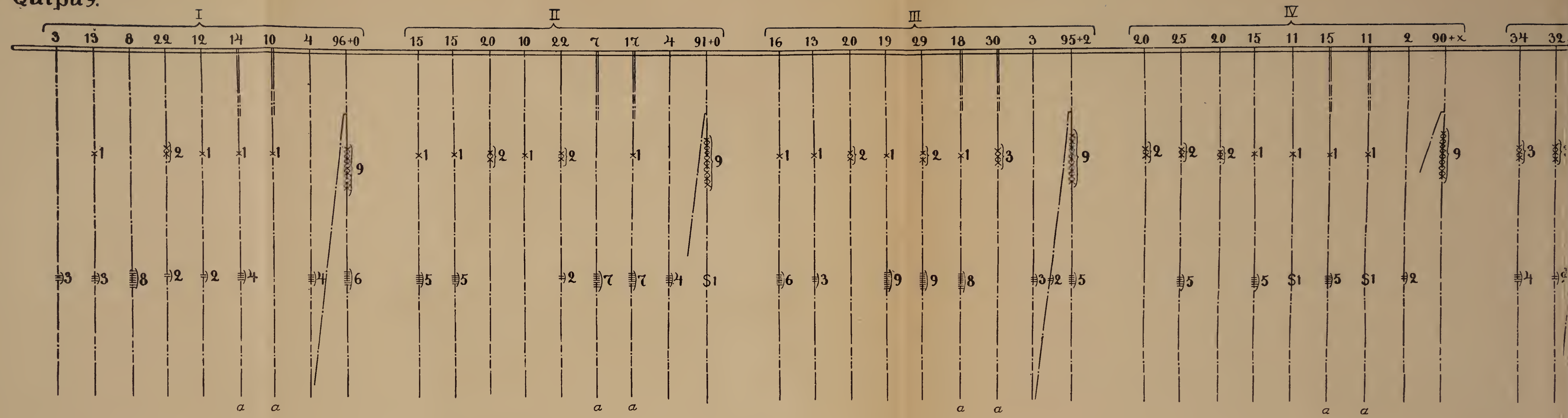
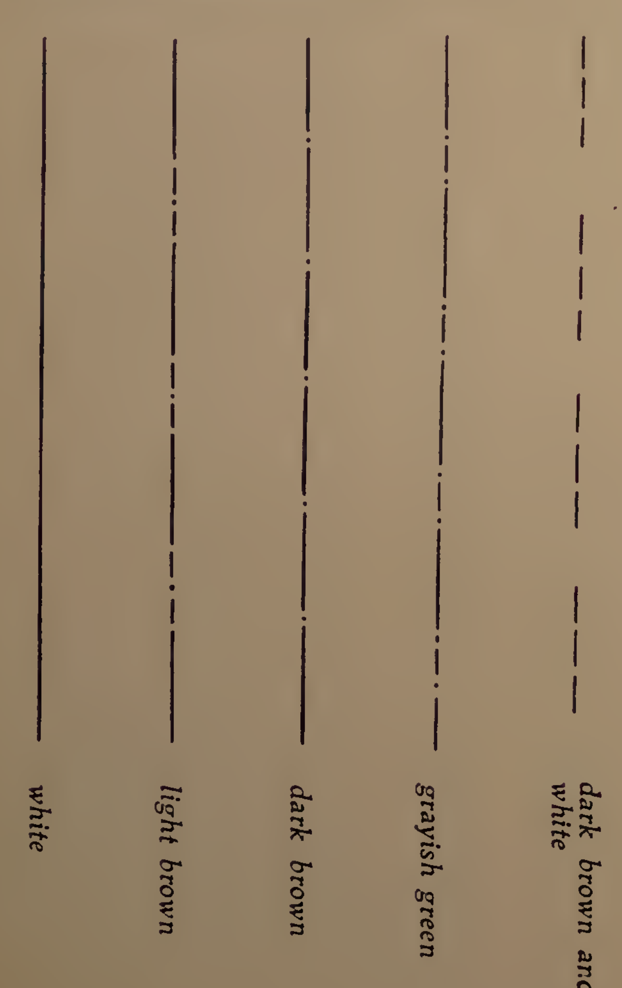
Key to the colours in quipu 9.



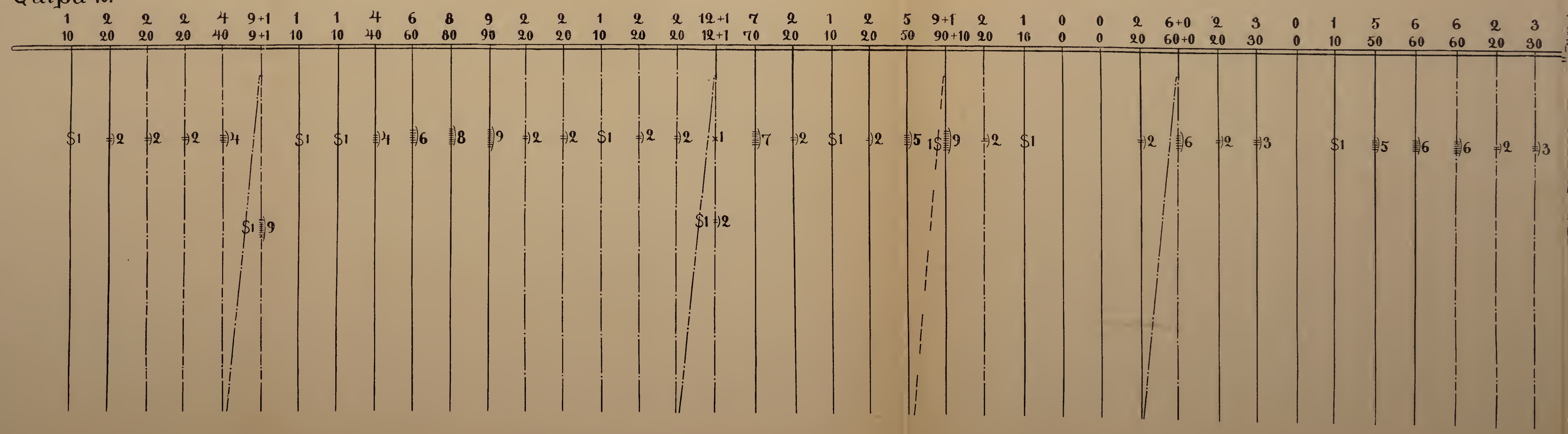
Quipu 9.



Key to the colours in quipu 10.



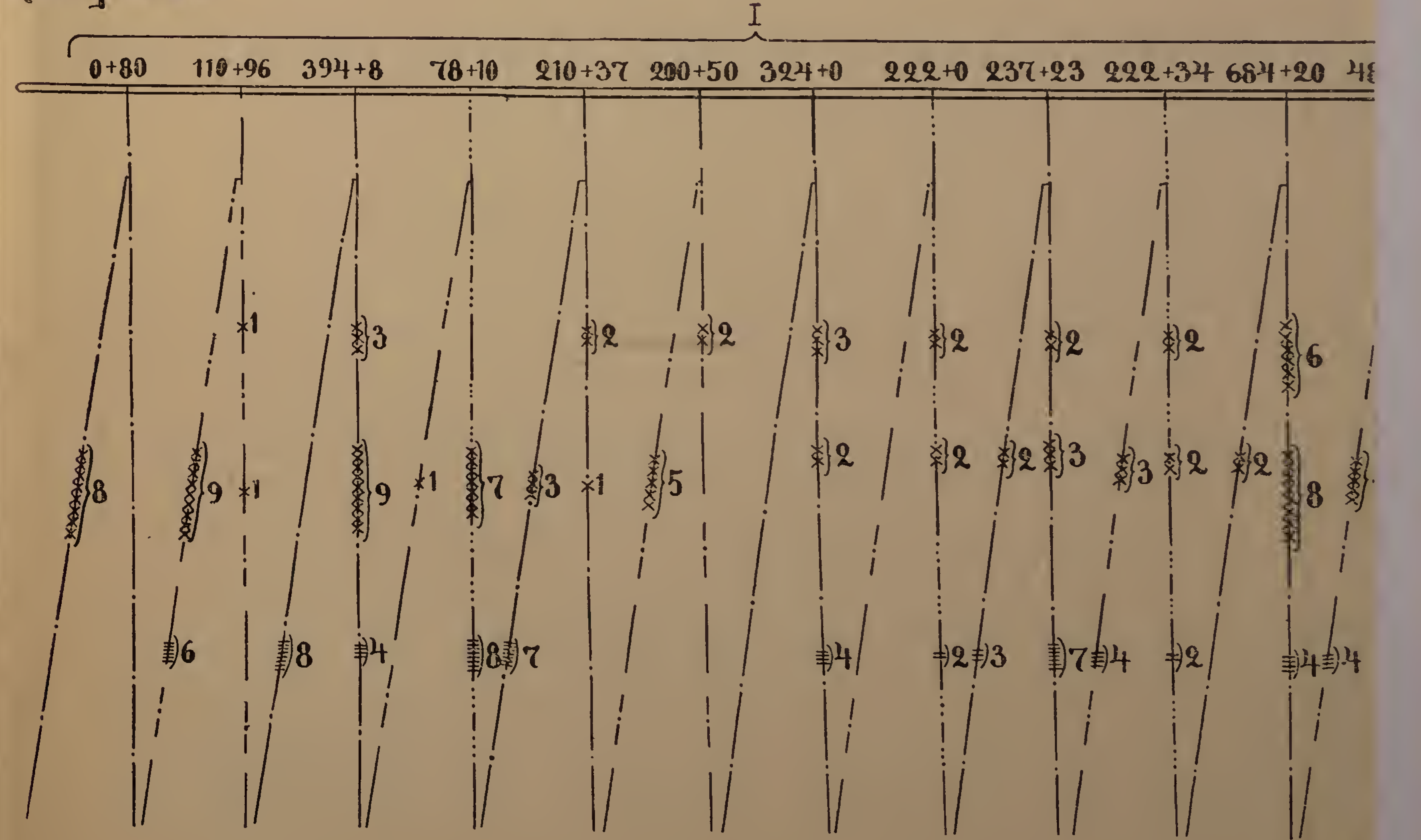
Quipu 10.

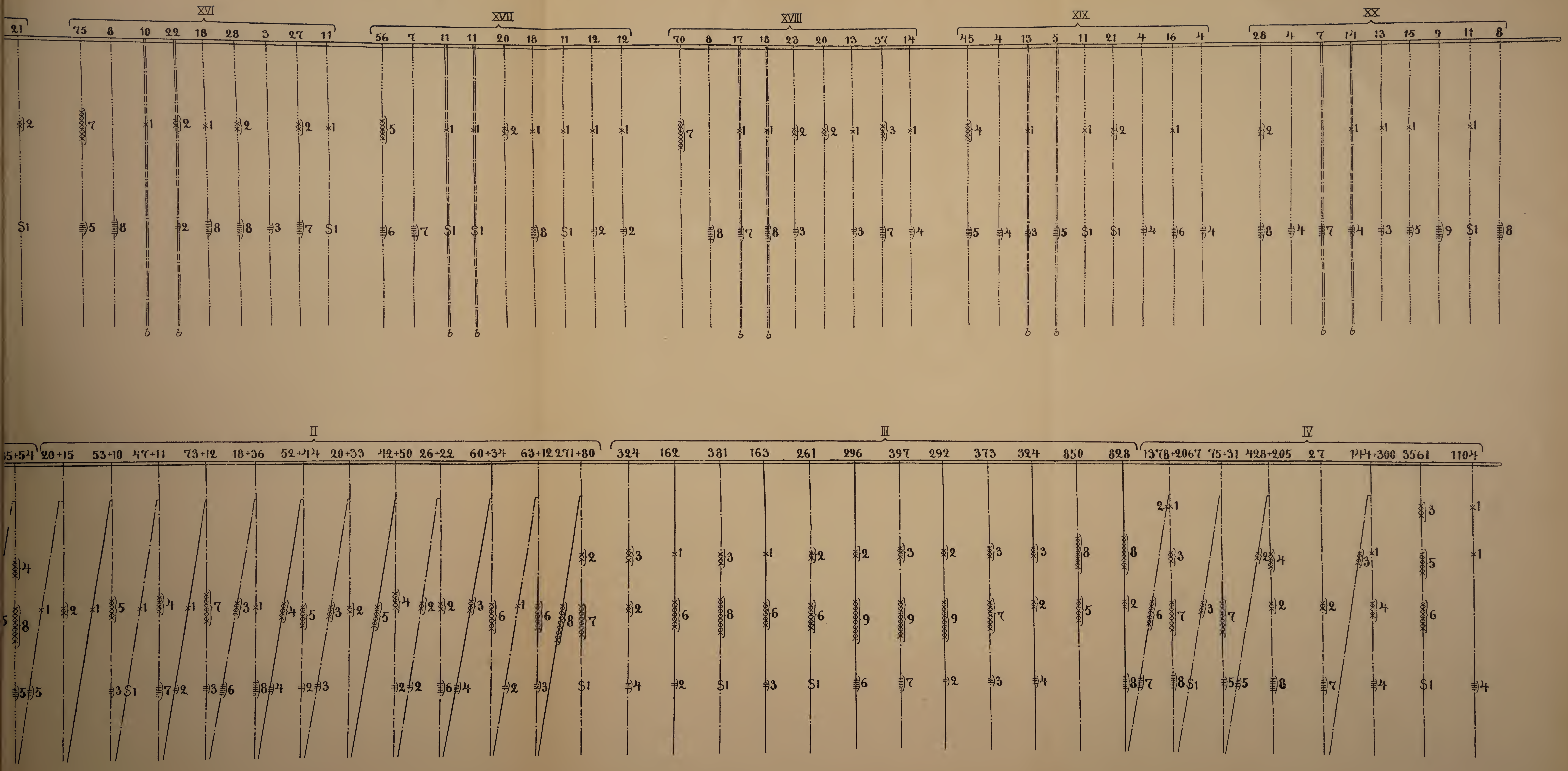



III
9 29 18 30 3 95+2
IV
20 25 20 15 11 15 11 2 90+x
V
34 32 23 23 12 25 18 7 98+1
VI
32 36 26 26 10 15 23 9 79+0
VII
9 10 16 18 11 6 14 2 93+1
VIII
22 18 14 36 10 5 17 2
a a a a a a a a b b b b
5 9+1 2 1 0 0 2 6+0 2 3 0 1 5 6 6 2 3 5 0 16+4 6 8 8 8 12 16+1 5 4 5 6 3 14+0 7 11 7 4 11 12+1 1 1 1 3 3 15+1 4 5 4 5 9 5 3
50 90+10 20 10 0 0 20 60+0 20 30 0 10 50 60 60 20 30 50 0 16+4 60 80 80 80 12 16+10 50 40 50 60 30 14+0 70 11 70 40 11 12+10 10 10 10 30 30 15+1 40 50 40 50 90 50 30

Key to the colours in quipu 12.

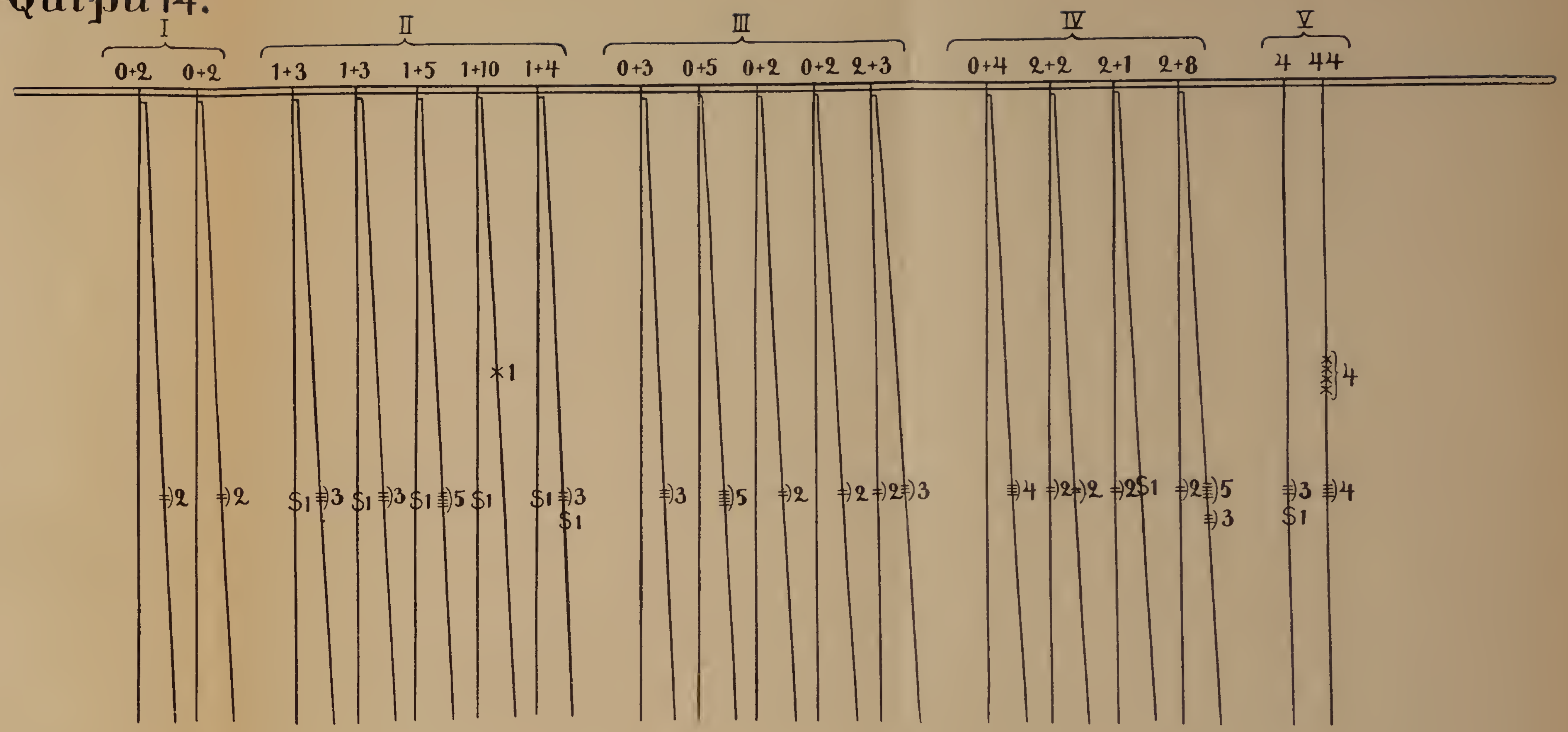
Quipu 12.





Quipu 11.

Quipu 14.

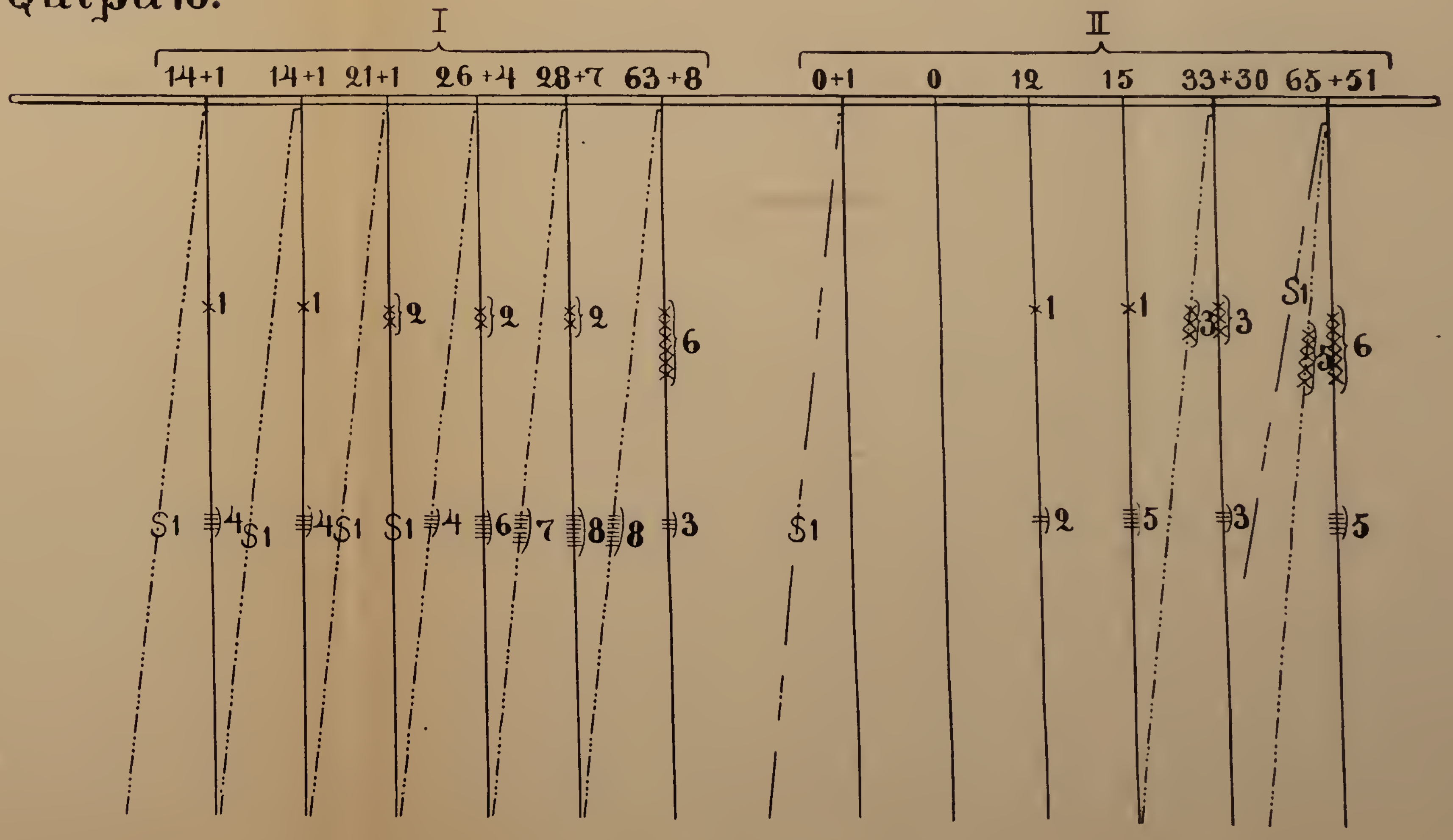


Key to the colours in quipu 15.

Quipu 15.

Key to the colours in quipu 16.

Quipu 16.



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