ETHNOLOGIE

The akan multiplication table. The akan weighing system, part two

La table de multiplication akan. Le système pondéral akan, deuxième partie

JEAN-JACQUES CRAPPIER[(1)] & PIERRE GASCOU[(2)]

[(1)] MD, Collector, Le Mans, France - rmjjc@orange.fr

[(2)] Engeneer, Collector, Versailles, France.

Citation : Crappier Jean-Jacques & Gascou P., 2020. The akan multiplication table. The akan weighing system, part two. *Colligo*, 3 (1). https://perma.cc/F4M8-GZ97

KEY-WORDS

akan, ashanti, baule, gold weight (goldweight, golgdewitch), Ghana, Côte d'Ivoire, Gold Coast, dualistic system, ethnomathematics, Timothy Garrard, Henry Abel, Rudolph Zeller, Louis Binger, taku, ba, mitqal, proto-currencies

MOTS-CLÉS

akan, ashanti, baoulé, poids à peser l'or, Ghana, Côte d'Ivoire, Gold Coast, système dualiste, ethno-mathématiques, Timothy Garrard, Henry Abel, Rudolph Zeller, Louis Binger, taku, ba, mitqal, proto-monnaies

Summary: In addition to a previous communication which showed the sophistication and the African origin of the Akan Weighing System, this article explains how, by the compilation of previous works sometimes more than a century old, the authors understood that it's acted of a dualistic system light weight / heavy weight and reconstituted the multiplication table which underlined the value of its various units. These hypotheses having been demonstrated with a very high level of evidence by the study of thousands of weights. It remains to be understood how the Akan were able to perform multiplications as complex as, for example 13 by 192, without being able to write the operation.

Résumé : En complément d'une précédente communication qui a montré la sophistication et l'origine africaine du système pondéral akan, cet article explique comment, par la compilation de travaux antérieurs vieux parfois de plus d'un siècle, les auteurs ont compris qu'il s'agissait d'un système dualiste poids-faible/poids-forts et reconstitué la table de multiplication qui sous-tendait la valeur de ses différentes unités. Ces hypothèses ayant été démontrées avec un très fort niveau de preuve par l'étude de milliers de poids, il reste à comprendre comment les Akan ont pu procéder à des multiplications aussi complexes que, par exemple 13 par 192, sans pouvoir, faute de numération écrite, poser l'opération.

Introduction

This article is the second in a series devoted to the study of the Akan gold weights, well known to collectors and ethnologists, but whose functioning has given rise to little research and remains poorly understood. In our original article, we showed, by studying the largest collection of geometric weights ever studied (9031 including 298 chef's weights over 80 g) (Crappier *et al.*, 2019), the organization and precision of this weighted system and invalidated the theory which made it derive from that of the Arabs, in favor of an African origin.

Our reasoning assumes that the weight distribution has obeyed a complex multiplication table, which we had only briefly explained, so as not to weigh down our demonstration. Our purpose is to fill this gap here and show how this so-called Akan Multiplication Table was constructed and to think about the problems it raises.

Method

To penetrate the Akan Weighing System (AWS), we have many lists of weights collected from the beginning of the 17th century by European merchants or explorers and field surveys carried out by Henri Abel and Timothy Garrard in the second half of the 20th century. But these lists, drawn up in Portuguese, Dutch, English or French units, are more or less exact and complete, and the field surveys suffer from having been carried out several generations after the Akan stopped using them. Data interpretation is complicated by great linguistic variability and a gradual tangle over time. It is therefore not surprising that the authors who studied it during the 20th century, all came to different conclusions about the nature and functioning of AWS, and that the work ended there.

Despite the passage of time and the uncertainty about data, it seemed possible to propose a synthesis of the different theories from four main sources which are in chronological order the publications of Louis Gustave Binger in 1892, of Rudolph Zeller in 1903, by Henri Abel from 1952 to 1973 and by Timothy Garrard in 1982. We have dissected the lists of weights reported by these authors to understand their structure. We translated them in the form of tables that an overview is enough to understand the reasoning that led us to the Akan Multiplication Table. The interested reader will find more detailed information in the framed texts.

To find your way around the weights and coins of Europeans:

The Portuguese were the first to come into contact with Akan people in 1471 and to obtain a coastal concession in 1482. Their currency was the Cruzado, weighing (until 1584), 3.6 g and containing 0.358 g of fine gold (almost 24 carats). They used to weigh gold the Cologne ounce of 28.7 g they called *onça*.

The Dutch of the United Provinces supplanted the Portuguese in 1637. They had a Ducat of 3.5 g of 23.5 carat gold, but mainly struck silver *Rijksdaaler*. They used a Troy ounce of 30.7 g.

The English came into play in the last quarter of the 17th century. They will take 200 years to oust the Dutch competition on the Gold Coast, before undertaking the conquest of the interior of the country to the detriment of the Ashanti. Their monetary unit was the Sovereign (£), weighing 7.99 g, containing 7.32 g of fine gold (22 carats). Their Troy ounce (Ozt) weighs 31.1 g.

The French, who arrived too late, did not manage to settle, except, from 1842, on the "Coast of the Teeth", in the western part of the Akan states. The Franc weighs 0.32 g and contains 0.29 g of fine gold (21.6 carats). They used in Africa a "trade ounce" of 32 g.

Results

The weight lists allow us to get a precise idea of the relationship between them of the main Akan weights denominations, but as they are established, for the most part, in monetary equivalent value, they do not give us directly the corresponding mass. To calculate it, we must therefore know the price at which an ounce of akan gold was negotiated, knowing that these ounces, like currencies, differed from one country to another, that the fine metal content was variously appreciated by Europeans traders, and that it varied depending on whether it was gold dust or nuggets.

There were 3 kinds of units:

- Basic units which rest on seeds, the *ba*, and the *taku* [1], in a ratio between them of 3 *ba* for 2 *taku*. The *ba* is worth 2 *damma*, that is to say two seeds of *Abrus precatorius*, a forest liana. Taku is also a seed, but its exact nature is unknown to the authors;

- *Ake* [2] is another frequently cited unit, given for 1/16 of an ounce. An *ake* is worth 8 *taku*;

- The *benna* [3] which is worth 2 ounces, whether Portuguese, Dutch or English, is therefore worth 256 *taku*.

Typically, the name akan of weights is formed by a radical (*ba* or *taku* for small units) followed by a suffix which can mean either a "multiplication by", or more rarely an "addition of". There are thus around twenty radicals and their multiples by 1/2, 2, 3 or 4, sometimes up to 8, corresponding to around sixty different weights.

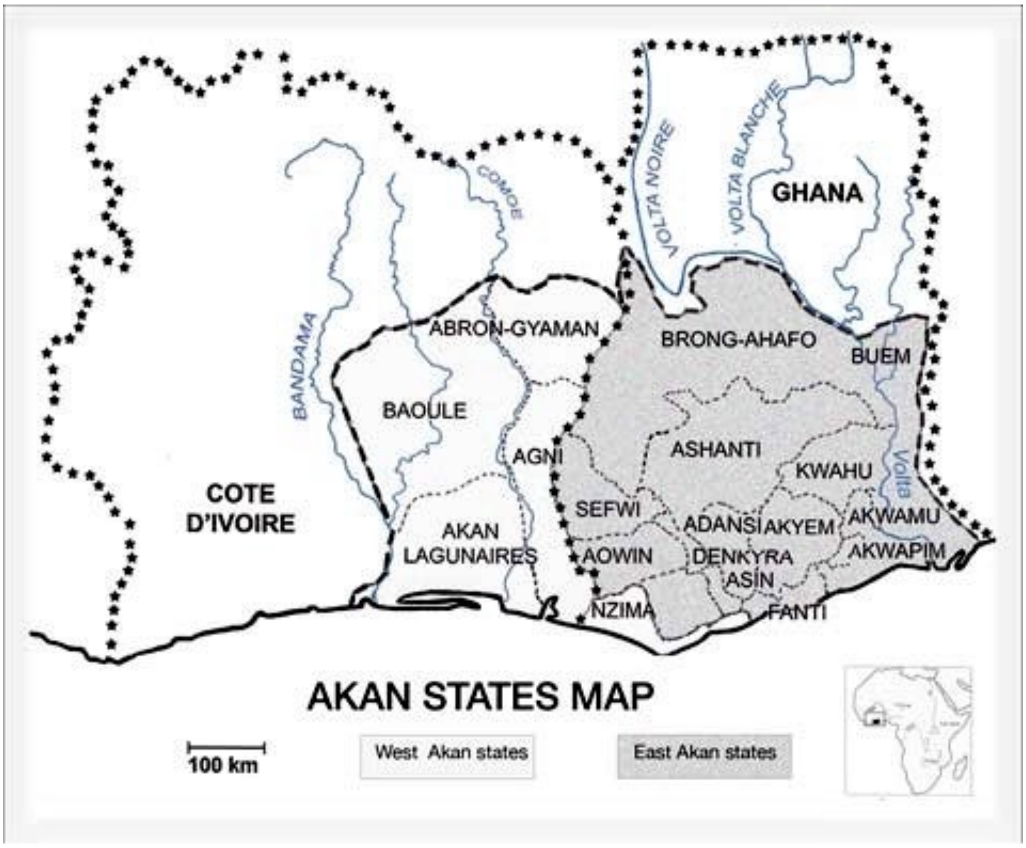
Standardized numbering

Although they belong to the same linguistic group, the Akan languages differ significantly from one state to another and the names of the weights vary, in particular between eastern and western states (see **map**), or take different values. To facilitate the comparison between the different sources, we have simplified and standardized the Akan numeration (**Table 1**). For more information, the reader will refer to **Appendix 1**, reproduced from Bowdich, which shows all its complexity (Bowdich, 1819). We have used Ashanti names for Eastern Akan lists and Baule names for Western Akan lists, with their simplest spelling since the European translation is arbitrary. To avoid confusion, the word weight will henceforth be

1. *Tokoo, takou, takoi or tekkoo.*

2. *Akye, ackie, acquay* or *akee.*

3. *Benna, banna* or benda.



½= fa or suru*	1 = ko	2 = no	3 = nsa	4 = nan	5 = nun
	6 = asia	7 = nso	8 = otwe	9 = gun	10 = buru
* *The suffix suru can mean either [x 1/2] or [+ 1/2]. Ne means plus*					

Table 1. Simplified akan numeration.

reserved for the designation of objects, and the word mass for their value in grams.

Weight classification according to Zeller (1869-1940)

Rudolph Zeller, director of the ethnographic section of the Historical Museum of Bern is the first, in 1913, to publish a synthesis of the Akan Weighing System, from information provided by Rudolph Bürki, a Swiss missionary who lived in Gold-Coast [4] at the beginning of the 20th century, and from older lists established when the weights were still in use. The data are of Akyem and Ashanti origin, so eastern akan. Zeller's system is based on the *taku*, whose weight he calculates at 0.25 g. He doesn't talk about *ba*. He distributes the weights into 8 series [5], the main 7 of which have 1,3,5,7,9,11 and 13 *taku* as their first term, and each element of which is double the previous one. He presents his results in the form of a table (**Appendix 2**) which can easily be transformed into a multiplication table composed of 7 columns, one per series, the first weights of which are respectively 1,3,5,7,9,11 and 13 *taku*, and of a dozen lines corresponding to multipliers by the powers of 2, that is to say 2,4,8 and so on until 2048 for series 1 (**Table 2**).

Zeller also claims that the *mitqal* [6], the weight of Arab origin which represents the mass of a dinar [7], was not used in the Gold Coast and reports the testimony of Christaller affirming that the Akan used different weights to buy or sell (Zeller, 1903).

4. Name given by the English to the colony that will become Ghana.

5. The first series is based on the *damma*, 2 of which make a *ba*, although he does not quote this last unit.

6. *Mithqal*, *mitiqal* or *mitkal*.

7. Arabian currency with a canonical weight of 4.25 g of almost pure gold.

	S1	S3	S5	S7	S9	S11	S13
1	1 (0,25 g) **TAKU**	3 (0,75 g) taku-nsa		7 (1,75 g) domma-fa	9 (2,25 g) **AGIRAOTWE-FA**	11 (2,75 g) bodomo-fa	13 (3,25 g) fiaso
2		6 (1,5 g) sowa-fa	10 (2,5 g) nsonsa-fa	14 (3,5 g) domma	18 (4,5 g) agiraotwe	22 (5,5 g) bodomo	26 (6,5 g) nsa-no
4		12 (3 g) sowa	20 (5 g) nso-nsa	28 (7 g) dwoa-suru	36 (9 g) suru	44 (11 g) takimansua	
8	8 (2 g) borofo-fa	24 (6 g) nsano	40 (10 g) pere-suru	56 (14 g) dwoa	72 (18 g) osua		
16	16 (4 g) borofo	48 (12 g) asia			144 (36 g) osua-no		
24					216 (54 g) osua-nsa		
32	32 (8 g) namfi-suru	96 (24 g)	160 (40 g) dwoano ne dwoasuru		288 (72 g) pereguan = nta ➥	x40=360 (90 g) pereguan osua	
48	asia (12g)				432 (104 g) pereguan osuano		
64	64 (16 g) namfi	192 (48 g) egwa-nsa			576 (144 g) pereguan-no ➥	x80=720 (180 g) pereguan no osuano	
96					864 (208 g) pereguan-nsa		
128	128 (32 g) benna-fa						
256 ➥	256 (64 g) **BENNA** ➥	x 512 (128 g) benna-no ➥	x 768 (192 g) benna-nsa ➥	x1024 (256 g) benna-nan ➥	x2048 (512 g) benna-otwe		

Table 2. 1 *taku* = 0.25 g. Ashanti appellations. According to *tabelle III* et *IV* of Zeller. Values are given in *taku.*

Weight classification according to Garrard (1943-2007)

An English native, Timothy Garrard spent most of his career in Ghana as a lawyer and ethnologist. His work is authoritative in terms of Akan weight. His theory contradicts that of Zeller. For him, the AWS is a loan from the Arabs, the basic unit of which was the *mitqal* of 4.4 g and the *uqiya*, the Arabic ounce, of 26.4 g. The Akan are said to have learned from the Dioula, a caste of Islamized Soninke merchants, who traded with the two parties in the context of the trans-Saharan trade. They would later have added European weights to it, once contact had been established with them, thus explaining the complexity of the system, which he said consisted of four series, two modeled after the Arab weights (one on *mitqal*, the other on *uqiya*), one on the Portuguese weights, and the last one on English weights, each weight being, in a series, twice the previous one (**Appendix 3**). The *uquiya* series is said to have been used mostly among western Akan.

The *taku*, to which he attributes the mass of 0.25 g like Zeller, and the *ba*, would have played only an ancillary role for small transactions. He does not find a trace in his investigations of the difference between weight to sell and weight to buy (Garrard, 1982).

This thesis is well argued, but is contradicted by the lists of weights which he himself collected in the various Akan states from notables who still knew their names and their counter values in English currency. None of them cites *mitqal*, but all report a 6 pence *taku* weighing 0.22 g. The summary table which he

	S1	S3	S5	S7	S9	S11	S13
1	1 (0,22 g) **TAKU**	3 (0,66 g) taku-nsa	5 (1,1 g) taku-nun	7 (1,54 g) domma-fa	9 (1,98 g) **AGIRAOTWE-FA**	11 (2,42 g) bodomo-fa	13 (2,86 g) fiaso (ak)
2	2 (0,44 g) taku-no	6 (1,32 g) sowa-fa	10 (2,2 g) nsonsa-fa	14 (3,08 g) domma	18 (3,9 g) agiraotwe	22 (4,84) bodomo	26 (5,72 g) nsano
4	4 (0,88 g) taku-nan	12 (2,64 g) sowa	20 (4,4 g) nso-nsa		36 (7,8 g) onansua-suru	44 (9,68 g) pere-suru	52 (11,44 g) asia
6			30 (6,6 g) dwoa-suru				
8	8 (1,76 g) borofo-fa	24 (5,28 g) sowa-no	40 (8,8 g) suru		72 (15,6g) onansua		
			60 (13,2 g) dwoa				
16	16 (3,52 g) borofo	47 (48-10,56 g) techimansua	80 (17,6 g) osua		144 (31,7 g) dwoa-no (ak)		200 (208-43,76 g) osuano ne suru
24			120 (26,4 g) osua ne suru				
32	32 (7,04 g) namfi-suru	94 (96-21,1 g) osua ne domma	160 (35,2 g) osua-no		280 (288-61,6 g) **BENNA**		
48			240 (52,8 g) osua-nsa				
64	64 (14,08 g) namfi	186 (192-42,2 g) osuano ne nsano	320 (70,4 g) pereguan = nta				
96	96 (21,12 g) *osua ne borofo*		480 (106 g) pereguan osua-no				
128		372 (384-84,5 g) pereguan ne asia	640 (141 g) pereguan-no				
			nta-nsa				
256		744 (768-169 g) pereguan no ne osua-no	1280 (282 g) pereguan-nan				
			pereguan nun				

Table 3. 1 *taku* = 0.22 g. Ashanti appellations. According to Garrard, p. 348-349. The values are given in *taku*.

establishes from the lists of 16 different states is too large to be carried over here. We only cite (**Appendix 4**) the Ashanti and Akyem lists which allow to find, on the basis of a *taku* of 0.22 g, the seven series of Zeller, and to reconstruct, albeit in a different order, a multiplication table (**Table 3**).

Weight classification according to Binger (1856-1936)

Captain of the Marine Infantry, Louis-Gustave Binger explored West Africa. He ended his career as governor of Ivory Coast. The account of his trip from Niger to the Gulf of Guinea is our third source (Binger, 1892). Precisely that of his stay in 1889 in Agni country, a western Akan people, of which he wrote down the list of weights (**Annex 6**). It is established on the basis of an ounce rounded to 32 g, and a price of 3 francs per gram of gold ore. The basic unit is the *ba* which is worth 50 c and therefore weighs 1.66 g. (It is equivalent to 2/3 of the 0.25 g *taku*). The mass of the *damma* seed must therefore be 0.83 g. This list can, like the others, be transformed in a multiplication table (**Table 4**), on the model of that of **Table 2**.

X	S1	S3	S5	S7	S9	S11	S13
1/2	½ (0,08 g) damma	1,5 (0,25 g) ba ne damma	0,36 (0,41 g) ba-no ne damma				
1	1 (0,166 g) **BA**	3 (0,5 g) ba-san (3)	5 (0,83 g ba-nun (5)	7 (1,16 g) ba-nsa	9 (1,5 g) ba-gun (9)	11 (1,83 g) baburu ne ko	13 (2,16 g) meteba ne ko
2	2 (0,33 g) ba-no	6 (1 g) ba-zien (6)	10 (1,66 g) ba-buru (10)	14 (2,32 g) nso-no	18 / 3 g assoba	22 (3,66 g) nsonsa ne ba-no	26 (4,5 g) nso-nsa
3				21 (3,48 g) nso-nsa			
4	4 (0,66 g) ba nan (4)	12 (2 g) **METEBA**			36 (6 g) bandia-suru	44 (7,32 g) tra	
6			30 (4,98 g) kuabo		54 (9 g) bari		
8	8 (1,32 g) ba-otwe (8)	24 (4 g) simbari-fa	40 (6,64 g) anui-suru		72 (12 g) bandia	88 (14,6 g) gua	
12			60 (9,96 g) nsonsa-nsa		108 (18 g) bandia-suru		
16	16 (2,64 g) baotwe-no	48 (8 g) simbari	80 (13,3 g) anui		144 (24 g) ba-ndea		
24			120 (20 g) essan-no	x18 (126-42 g) ndua-san	216 (36 g) attatue		312 (52 g) nta
32	32 (5,28 g) ndara-suru	96 (16 g) anan	160 (26,6 g) anui-no				
64	64 (10,6 g) gbang-bandia	192 (32 g) anan-no	x 48 (240-39,9 g) anui-nsa ➥	x 96 (480-80 g) *(anuinsa-no)* ➥	x 192 (960-160 g) anuinsa-nan		
128	128 (21,2 g) gbangbandia-no	384 (64 g) **BANNA**					

Tableau 4. 1 *ba* = 0.166 g = 50 c. Baule appellations. According to Binger. The values are given in *ba*.

Weight classification according to Abel (1896-1958)

French colonial administrator, Henri Abel was Mayor of Abidjan from 1948 to 1952. His field investigations in 1952 in Baule, Agni and Aboure countries, therefore in the Western Akan area, enabled him to meet notables who still had weights, who they no longer knew how to use, but whose names and values they knew in Fr or in £. His informants report to him a system based on *taku* and *ba* and comprising for each unit male and female weights (Abel, 1973). The analysis of their appellations allows him to classify them into seven series like Zeller and, by weighing them, to calculate the mass of *ba* and *taku*, respectively 0.146 g and 0.22 g (in the ratio of 3 to 2). The idea of transforming the lists into a multiplication table came from him, but the one he establishes, both in *ba* and in *taku*, is complex and wobbly (**Appendix** 7). Reconstructed with 1,3,5,7,9,11,13 ba as the baseline, it finds a coherent structure according to the model of Binger (**Table 5**).

Synthesis

Four documented and credible sources, four different units, contradictory interpretations, but four tables from which lessons emerge on the Akan weighting system:

- The possibility to distribute the weights in 7 series, within which each unit is the multiple by 2, sometimes by 3, of the previous one;

- The preferential use of *ba* in the western states and *taku* in the eastern states;

- The coexistence in each region of light units and heavy units: in the west a light *ba* of 0.146 g and a heavy *ba* of 0.166 g, in the east a light *taku* of 0.22 g and a heavy *taku* of 0, 25 g,

x	S1	S3	S5	S7	S9	S11	S13
1/2	½ (0,074 g) damma	1,5 (0,22 g) **TAKU**					
1	1 (0,146 g) **BA**	3 (0,44 g) ba-nsa	5 (0,73 g) ba-nun	7 (1,02 g) ba-nso	9 (1,31 g) ba-gun	11 (1,60 g) ba-buru ne ko	13 (1,9 g) meteba ne ko
2	2 (0,29 g) ba-no	6 (0,88 g) ba-asia	10 (1,46 g) ba-buru	14 (2,04 g) nso-no	18 (2,62 g) asia-nsa	22 (3,20 g) nso-nsa ne ko	
3				21 (2,06 g) nso-nsa			
4	4 (0,58 g) ba-nan	12 (1,76 g) **METEBA**	20 (2,92 g) assoba	28 (4,08 g) simbari-fa	36 (5,24 g) ndara-suru	44 (6,40 g) anui-suru	
6			30 (4,4 g) nso-nsa				
8	8 (1,16g) ba-otwe	24 (3,52 g) otwe-nsa	40 (5,84 g) bandia-suru	56 (8,17 g) simbari	72 (10,48 g) gbangbandia	88 (12,8 g) anui	
12			60 (8,8 g) bari £				
16	16 (2,32 g) ba-otwe no	48 (7,04 g) tra	80 (11,68 g) bandia	112 (16,35) anan	144 (20,96 g) gbangbandia-no	176 (25,6 g) anui-no	
24			120 (17,6 g) bandia-suru			264 (38,4 g) anui-nsa	
32	32 (4,64 g) kuabo	96 (14,08 g) gua	160 (23,36 g) bandia-no	224 (32,7 g) anan-no	288 (41,92 g) gua-nsa	352 (51,2 g) anui-nan	
48			240 (35,2 g) atakpi				
64	64 (9,28 g) assan	192 (28,2 g) gua-no	360 (52,8 g) nta	448 (65,40 g) **BANNA**			
96			480 (70,2 g) pereguan				
128	128 (18,56 g) assan-no	384 (56,32 g) **BENDA**	x192= 960 pereguan-no ➥	x384=1920 (280,8 g) pereguan-nan			

Tableau 5. 1 *ba* = 0.146 g. 1 *taku* = 0,22 g. Baule appellations. According to Abel. The values are given in *ba*.

in a light to heavy ratio of 8 to 7;

- Different appellations between western and eastern peoples, but which within each region are common to light and heavy weights. Sometimes with constant value (the weights of the same name have the same number of seeds but a different mass), sometimes with constant mass (the mass is constant but the number of seeds is different).

We conclude that the Akan, whose daily payments were made of gold dust, probably used, as Abel said, who was however mistaken about its nature [8], a dualist system of light weight / heavy weight based on the difference between light and heavy seeds: light ba and taku (now denoted B and T) to buy at low price, or make a loan, and heavy *ba* and *taku* (denoted B * and T *) to resell at high price or recover a debt with interest.

We also deduce a multiplication table common to the 2 regions and to the light and heavy subsystems by compiling tables 2, 3, 4 and 5, by filling in the missing boxes and by adding multipliers by 192, 384... 1536 which we let's call Akan Multiplication Table (**Appendix** 7). In doing so, we predict values unknown from our sources but which we should find by weighing the weights that we have collected, in particular that of the 298 chef weights.

8. Since he only described it within the light system, the only one he knew, with insufficient margin to be operative (**Annexe 6**).

ETHNOLOGIE

Table 2 comments:

How did Zeller calculate the value of the *taku*?

He averaged 9 *agiraotwe* (*agira* x 8) worth 16 *taku*, identified as such by Burki. He obtained 0.2585 g. He also calculated 1/256 of the mass of the *benna*, known to be worth 2 ounces. Theoretically 62.2 g in the troy system, which gives 0.243 g for the *taku*, but in this case counted for 64 g, which gives it the mass of 0.25 g, rounded value which will then be taken up by the most authors.

What is its equivalent in English currency?

For Zeller, *taku* is worth 7 pence (d). A Sovereign of gold which contains 20 shillings (s) of 12 d therefore corresponds to 0.25: 7 x 240 = 8.57 g of Akan gold, the purity of which is thus evaluated at 850 ‰ or 20, 4 carats. A troy ounce is worth 3 £ 12 s 6d. Zeller does not cite a weight corresponding to 1 £, but the latter is usually given for *suru* (S9), which is presumably the apheresis of *osua suru*. In this table, it is rounded to 9 g.

This table, like the following, uses our standardized numbering. Each series is made up of 4 to 10 units whose names are composite. In each box of the table appears the value in *taku*, followed in brackets by the mass in grams. Appellations are Ashanti, they appear on the second line. Values lower than *taku* have not been indicated. There are 43 different appellations. *Ake* does not appear as such but with the name of *agiraotwe-fa* (*agira* x 8: 2). It weighs 2 g (S1). *Asia* is worth 6 *ake*. In this same series, the multiples of *benna* appear for convenience in line 256. Series 11 and 13 are the least represented. For series 9 only, there are multiples by 24, 48 and 96, and even by 40 and 80 (these last 2 appearing for convenience in shaded boxes of column S11). These two unusual multiples, that appear in the column of S11, correspond to £ 10 and £ 20. Finally, note that *nso-nsa* (S5) which corresponds to the *mitqal*, and which results in 7 x 3 = 21 is in box 20 *taku*. We will discuss this anomaly in a further article.

Table 3 comments:

What value of *taku* Garrard did he choose?

He gives it the value of 0.26 g, close to the 0.258 g calculated by Zeller and corresponding, according to him, to the value attributed to *taku* by Mc Lean in 1847, on the basis of £ 4 for an Ozt.

What weight should *taku* have in function of its equivalent in English currency?

Contradictorily, Garrard is based on 3 £ 12 s for 1 Ozt, which corresponds to 8.64 g for 1 £, which he rounds to 8.8 g (830 ‰ = 20 carats). He takes this information from elderly notables from different Akan states, which also report a counter value of 6 d for 1 *taku*. It therefore weighs 0.22g. Garrard will not take it into account, but this is the value we used to build this table consistently, according to the Ashanti weight lists. Forty *taku* are worth £ 1, which corresponds in the table to *suru* (S5).

The number of lines is 16, due to new multiples by 6, 12, 192 and 320. Values lighter than *taku* have not been specified. The appellations have been brought into line with those of Zeller. There are 47. Some values change series compared to those of Zeller, especially for S9, several values of which are in S5. Two names, missing from the Ashanti list, are of akyem (ak) origin: *dwoano* (S9) and *fiaso* (S13)

Irregularities: The transcription into *taku* of the Ashanti weights gives for the series 3,9 and 13 irregular results. The expected value is indicated in brackets. *Benna*, who appeared for 256 *taku* in series 1 of Zeller is found in series 9, counted 280 *taku* instead of 288. This irregularity gives him the value of 2 Dutch Ozt. Similarly, *osuano suru* (S13), which counted 200 *taku* instead of 208 corresponds to £ 5. All these irregular values do not come from the multiplication table, but from the sum of the existing weights. Finally, *nso-nsa* is also counted there for 20 instead of 21 which gives it the value of 4.4 g that Garrard attributes to the *mitqal*.

Table 4 comments:

What does Binger teach us about *ba* and *taku*?

Binger uses a trade ounce weighing 32 g, worth 96 francs, for his calculations. 1/3 of a gram of gold bought from the Agni is therefore worth 1 franc with a purity of 880 ‰ (21 carats). The *ba*, that makes 2 *damma*, is sometimes called *taku*, which does not exist as such in the list. It is worth 50 c, its mass is therefore 1/6 of a gram, or 0.166 g. This value is in a ratio of 3 to 2 with the *taku* of Zeller. A *damma* seed should weigh 0.083 g.

The names of the weights have been translated into Baule, but the original list (**Appendix 5**) is Agni. They are different from Ashanti names. The numbering is that of **Table 1**. This table has 48 units, and 13 lines, 16 if we take in account an additional multiple by 18 of S7 and by 48, 96 and 192 of S5 (these last 3 appearing for convenience in shaded boxes of line 64). The *pereguan* which should make 480 *ba* (240 Francs) does not appear in Binger's list, but as its double is one of them, we have added it under the name of *anui-nsa-no*. The transcription of the Akan weights in Francs leads to drifts that we have corrected at best.

The table is constructed in *ba*, but we can feel the presence of *taku*. Thus *nso-nsa* appears for once in the S7 x 3 box, but it is also found in S13 x 2, that is 4.5 g = 20 *taku*, close to Garrard's *mitqal*. More obvious, the existence of multiples by 6, 12 and 24 (up to 192 for S5), which a 2/3 multiplication (4,8,16, 32 etc.) is enough to transform into *taku*. As in Zeller, the *ake* which appears under the name of *meteba*, weighs 2 g and *banna* 64 g.

In S5, *anui-suru* appears two times, as half *anui* and *anui* + ½ *anui*. Likewise for *bandia* in S9.

Table 5 comments:

How did Abel calculate *ba* and *taku*?

He calculated their masses by weighing weights, whose names and seed values he had obtained in 1952 from notables in Agni, Baule and Aboure states. He checked the value of *ba* by weighing seeds of *Abrus precatorius* (*damma*). The only copy of *taku* he had in his hand weighed 3 *damma* seeds, 0.22 g, but he did not identify the seed in question.

What is their equivalent value in European currency?

Abel cites two different values: one in franc, the other in English currency, but without drawing any conclusions about their masses, since he calculated them directly. We find the values of Binger and Garrard:

- on the one hand 50 cents for a *ba*, which at 3 francs a gram of gold gives it the mass of 0.166 g ;

- on the other hand 144 *taku* for one ounce, which in troy ounce gives 31.1 g: 144 = 0.216 g and in so-called trade ounce (32 g), 0.222 g.

This table uses our standardized numbering. There are 54 different values divided into 7 series. The names are Baule. For convenience, the multiples of 192 and 384 in series 5 appear in line 128 (shaded boxes).

The original structure of Abel's table, built in *ba* and *taku* around 7 eponymous values, chosen from among the most used, is flawed (see **annex 6**) but it becomes coherent after reorganization in *ba* on the model of previous tables. The appellations in *ba* are stable.

Bari and *simbari* change series by changing value to keep the same mass. *Bari* which weighs 8.8 g corresponds to £ 1. *Nsonsa* keeps its double identity with in S7 the same value of 21 *ba* as in Binger, and the same weight of 4.4 g, but passing in S5, with the same value of 30 *ba* (20 *taku* = 1 *mitqal*) than in Garrard. Abel distinguishes between *banna* (S7) of 65 g and *benda* of 56 g (S3) when these two terms are usually synonymous. *meteba*, which is worth an *ake*, weighs here 1.76g. As in the previous table, we go from *ba* to *taku* by multiplying by 2/3 the lines 6,12,24 etc.

Discussion

Even if we were able to show in our original article, with a very high level of evidence, the plausibility of our conclusions, the Akan Multiplication Table nonetheless raises many theoretical and practical questions:

1. Does milligram precision make sense?

It is obvious that such precision was inaccessible to the Akan, given the rusticity of their scales, but it should be remembered that these are calculated values and not actual values. This did not prevent them from using an even lighter unit than *ba*, the *pesewa*, corresponding to a grain of rice, weighing 0.04 g.

This precision in the calculations is however necessary because if the rounding in the value of the *ba* and the *taku* has only little consequences for small and up to medium values, they cause from *benna* a significant drift, drift that we do not find during the weighing of the chef's weights and which therefore did not exist in reality. This is understandable since the larger the number of seeds, the closer we get to their average value and therefore the more precise the measurement.

2. What do we know about the basic units?

- What is the nature of *ba* and *taku*?

If *ba* is correctly identified with the seed of *Abrus precatorius*, there is a doubt on its exact weight. The seed that corresponds to *taku* is not known. We come back to this in detail in a dedicated article [9].

- What do we know about *ake*?

Worth 1/16 of an ounce, it does not appear under this name in the weight lists that we have studied. It corresponds to the weight that the Akan called *metaba* in western countries, *agiraotwe-fa* in eastern. The origin of the word is controversial [10]. Our opinion is that it comes from the word *aquiay*, which in Brong Ahafo country (alias Booroom, see map and **Appendix 1**), corresponded to the number 8 and which is said in the other dialects *otwe*, or *awotwe*, or even *oque*, in the account made by de Marees of the Gold Coast (de Marees, 1605). Thus *ake* would simply mean 8 *taku*.

We are therefore dealing with a light *ake* of 1.79 g (denoted A) and a heavy *ake* of 1.94 g (denoted A *).

- What about the *benda*?

Benna in eastern states, *banna* or *benda* in western, every author gives him the value of 2 ounces and the weight of 62 g in one or the other light or heavy system. Abel is the only one to distinguish between a 56 g *benda* and a 65 g *benna*. We will discuss it again. This unit is not attached to a seed.

3. What information can we get from these tables?

Do *Ba* and *taku* have a different origin?

If we admit that the presentation in multiplication table had a real meaning for Akan, the fact that they are calculated in *taku* in eastern regions, and *ba* in western, is an argument in favor of a geographical separation of the two systems, although *taku* and *ake* were also used in western states. Tables, however, tell us nothing about the precedence of one system over the other.

We can thus better understand how Garrard, anxious to prove Arab origin of the AWS, comes to the conclusion that Western Akan preferentially used *uqiya*. The latter being worth 6 *mitqal*, its submultiples by 1/8, 1/4, 1/2, and its multiples by 2,4,8 and so on, are found in a ratio of 3 to 2 with those of *mitqal*, which transforms them, de facto, into multiples of *ba*. This explanation seems more solid than that of Garrard, who saw in it a difference between the trade of gold, more abundant in eastern regions, and usually weighed in *mitqal*, and the trade of ivory, more abundant in the west, heavier, and which would therefore have been weighed in *uqiya*.

9. See *Seeking for seeds*.

10. For some it would be *achtjen*, a Dutch unit worths 1/16 of an ounce of Cologne (Muller, 1673), for others it would be the seed of a tree called aki (Ott, 1968).

11. See *Story of taku and mitqal*.

12. These weights are stacks of nested cups, each of which being half the of the previous one. One finds commonly buckets of 1, 2 or 4 Ozt, and their divisions, in the collections of weights.

Which of the light or heavy systems would have preceded the other?

There are several clues in these lists that allow us to discuss it. Thus, the almost perfect regularity of tables in T* compared to the apparent disorder of tables in T pleads for an anteriority of the first compared to the second. It is to ignore that one of the first reports of the Akan weights, by de Marees, which dates from 1605, reports an *ake* of 1.79 g and a *benda* of 57 g, belonging to the light series, and that *nso-nsa*, which corresponds to *mitqal* and therefore to the trans-Saharan trade, which is even older, also comes under this system. We must therefore consider a coexistence and interpenetration of the two systems.

Can we conclude that the two systems coexisted?

Just as *ba* predominated in western states, and *taku* in eastern, one might think that the differences between light and heavy weights corresponded to regional peculiarities. For Ott, this was the case between the coastal states and those in the interior. He saw in it the way in which African importers, who went to the forts on the coast to buy from Europeans traders the commodities which they redistributed in the land, took their profit (Ott, 1968).

But weighing gold dust with the scales, spoons and containers held by the Akan is difficult, and adding a weight during weighing takes the risk of compromising a precarious balance and losing gold. We can therefore hypothesize, with Abel, a dualistic system used daily in each state.

To imagine how it could have worked, we have to distinguish two cases.

First, a direct transaction between producer and consumer, in which only the price asked by the seller intervenes, corresponding to a quantity of gold dust usually fixed by custom and indicated by the name of a weight. Negotiation involves the quality and weighing of gold, each using their own weights to verify the transaction. Only one weight system is required in this case.

The second situation is that of a loan, or a resale by a merchant, in which the dualist system takes on its full meaning, the merchant, or the lender, using light weights to buy the goods, or to make the loan, and heavy weights to resell it or recover the debt. The difference in gold dust between weight to sell and weight to buy representing their profit.

Then two questions arise:

- Is the profit margin of 1/7 (14%) consistent with this assumption? This rate seems suitable for a loan, and even usurious in an economy without inflation. For a sale on the other hand, the profit seems very low, except if we take into account the fact that Akan people knew neither VAT, nor social charges, and that their structural costs were low. 14% of net profit at the end of the year would satisfy more than one trader these days. Furthermore, with regard to trade with the Arabs or the Europeans, internal demand was such that the intermediaries, whether Dioula or Akan, had probably found a way to take a greater profit, either by reducing the quantities further , or by increasing prices anyway.

- How can we explain that European informants did not report this dualism?

Only three of them refer to it more or less explicitly, but most do not mention it. We will discuss about this in a next article [11]. This system being intended for transactions between Akan, there was no reason why foreigners, who were paid in gold, for goods whose price they calculated according to supply and demand, should have been informed. The diversity of Akan weights was such that they only had to know, from the system, that part which corresponded to their own monetary weights: light for the *mitqal*, *uqiya* and *onça*, heavy for Dutch and English Ozt.

4. A very complicated Akan Multiplication Table! (Appendix 7)

- We only have 10 fingers to count. Series 11 and 13 therefore seem counter-intuitive. Do they really exist?

- Why all these additional values compared to our sources? Are there missing units used among them by the Akan but unknown to their European partners?

- Does the predominance of multiples of 2 in these tables result from an observation bias, linked to the use by European merchants of nested cup weights which are designed on this principle [12].

The study of the 298 weights above 80 g, known as Chiefs' weights, allows us to answer these three questions in the affirmative:

- **Table 6** shows the boxes in which they are distributed according to the value to which

Serie	S1	S3	S5	S7	S9	S11	S13	Total lines
32						352 12	416 32	44
48				336 14	432 13	528 12	624 10	49
64			320 15	448 8	576 13	704 14	832 8	58
96			480 17	672 12	864 9	1056 5	1248 2	45
128		384 17	640 16	896 10	1152 4	1408 1	1664 3	51
192			960 9	1344 3	1728	2112 2	2496 1	15
256		768 9	1280 2	1792	2304 1	2816	3328	12
384			1920 2	2688	3456 2	4284	4992	4
512	512 7	1536	2560 1	3584	4608	5632 1		9
768			3840	5376	6912			0
1024	1024 5	3072	5120	7168 1				6
1536			7680 1					1
2048	2048	6144 2						2
4096	4096 2							2
Total	14	28	63	48	42	47	56	184 114

Tableau 6. Distribution of the 298 chief's weights according Akan Multiplication Table. In red, number of weights > 80 g per box.

they are closest after transformation into T or T *. Series 11 (47 weights) and 13 (56 weights) are particularly well represented and their existence is therefore in no doubt.

- Of the 55 boxes provided for weights over 80 g (at least 320 T *) 14 only are not occupied. There were therefore many weights unknown by Europeans whose existence can be predicted by the Akan Multiplication Table.

- There are 114 weights in lines 48, 96, 192 and so on, that's to say 38% of the chief's weights that cannot be weigh with nested cup weights. Their small number in European sources seems to be due to a bias, potentially linked to the use of these cup weights.

Can we delete the series 9?

The number 9 is not a prime number. It is a multiple of 3. Can we delete series 9 by supplementing series 3 with additional multiples?

This would not be impossible since the multiples of 9 by 2, 4, 8, 16 and 32 correspond to the multiples of 3 by 6, 12, 24, 48, 96. They therefore already appear in the table, but it would be necessary, to replace the other lost values of S9, to add multipliers of 3 by 9, 18, 36 and so on, up to 384, which would considerably complicate an already complex table, since they should logically be applied to the other series.

ETHNOLOGIE

Why do weights of the same name in light and heavy systems have the same mass?

We have already noticed that both in western and eastern states, certain weights of the same name changed values in number of seeds, keeping an almost identical mass, which is not consistent with the dualistic system. This is the case, among others, of *agiraotwe-fa*, but also of *suru*, *pereguan* and *benna*. How to take a sufficient profit by lending light *pereguan* (70.4 g) if the heavy *pereguan* that the creditor reimburses has the same mass? We see at least two reasons for this.

- The first is due to the haste with which gold was demonetized at the end of the 19th century by the English and French colonizers. Their system having lost all interest, the Akan have ceased to ensure its transmission and have kept the memory of their weights only by their equivalent value in English or French currency, forgetting their value in seeds. This is the case for the informants of Garrard, those of Burki and Abel still remembering their values in *taku* and *ba*.

- The second reason is the variations in £ of the price of Akan gold ore between the beginning and the end of the 19th century. In 1817, an Ozt was worth £ 4 (Bowdich, 1819), in 1880, it was only worth £ 3 12 s (Mollat, 2003). The date of this devaluation of 80 to 72 s, linked to a poorer gold content of the ore, is not known to us precisely, but it can be dated to the middle of the century, when the system was still in use. For the Akan, this was exactly like going from the heavy system to the light system.

Then you have to take in account human realities and the difficulty of adapting to change. Currencies change, men forget, but names stay. The sources on which we have worked are subsequent to these upheavals and reflect the confusions that then occurred. Only the oldest lists, those of Pieter de Marees (1605), Wilhelm Muller (1676) and Willem Bosman (1705) allow, with linguistic variations and with a few errors, to restore each weight to its fair value in the good system.

* if we calculate taku on the basis of a *benna* weighing 2 ozt (62.2 g)

5. How could the Akan, without written numbers, make such complex calculations?

Their language allowed them, with a lot of circumlocution, to formulate numbers greater than 100, but how did they perform operations as complicated as 13 x 192 = 2496 in the absence of written support [13]? how did they pass on their knowledge? Can we consider with Abel that the decorations of the geometric weights had a numerical meaning? We think so, and we are able to decipher many weights, but we have not found any reproducible structure in their coding, which is more like a rebus than an ordered numeration. We don't know how they did it, but we know they did it, since the weights are there to testify it, and that we have proven that their distribution was not due to chance.

13. To the numbers in **Table 1** we can add *oha* = 100 and *apem* = 1000 in Ashanti. Thus 2496 would be said: *Ahem-no ne oha-nan ne buru-otwe ne asia* which is not easy.

One way to circumscribe the problem is to assess the number of people involved. On a population of 1,400,000 Akan on the eve of colonization, Garrard evaluated the possessors of weight at 60,000, sharing a cumulative production over the centuries of three million weights, thus fifty each, and the number of goldsmiths in activity to a hundred. It was therefore a social and professional elite. If the owners of weights would easily memorized their value, the goldsmiths, whose Garrard estimates annual weight production at 100, could be the only ones to know all the subtleties.

One can nevertheless wonder if this multiplication table was really used as a means of calculation and if it is not a mathematical artefact, linked to the geometric structure of the series of weights, which appears when we translate into our units. If this were the case, this would open up the possibility of alternative calculation methods, as ethno-mathematicians have studied, for example, among the Siamou in Burkina-Fiaso (Traoré, 2008). But that does not change the value of what we have called the Akan Multiplication Table as a tool to unravel the skein of Akan gold weights.

Conclusion

This article allowed us to explain how we built the Akan Multiplication Table from multiple sources, to detail its intricacies and to discuss its relevance. It is not ultimately excluded that it is the result of a mathematical bias that we are not qualified to demonstrate. But, since the quality of a scientific theory is judged by the predictions it allows, we consider that this one, with which we have both proved the dualism of the Akan Weighting System and predicted the distribution of *chief's weights*, is the one who describes it the best, except to discover how the Akan would have proceeded differently to calculate their weights. The floor is open to ethno-mathematicians.

References

ABEL H., 1952-1959. Déchiffrement des poids à peser l'or en Côte d'Ivoire. *Journal de la Société des Africanistes*, 22: 95-114 (1952); 24: 7-23 (1954); 29: 273-286 (1959).

BINGER L. G., 1892. *Du Niger au Golfe de Guinée par le pays de Kong et le Mossi.* Paris, Hachette, 2 vol. (vol. premier, 513 p.; vol. second, 414 p.).

BOWDICH T. E., 1819. *Mission from Cape Coast Castle to Ashantee, with a statistical account of that kingdom, and geographical notices of other parts of the Interior of Africa.* London, John Murray, 512 p. [Ed. Frank Cass, 1966].

CRAPPIER J.-J., FARINETTO C., GASCOU P., MAUNOURY C., MAUNOURY F. & MATEUSEN G., 2019. The Akan Weighing System restored after 120 years of oblivion. A metrological study of 9301 geometric gold-weights. *Colligo*, 2(2). https://perma.cc/H494-E42R

De Marees P., 1605. *Description et récit historial du riche royaume d'or de Gunea (sic), aultrement nommé, la coste d'or de Mina, gisante en certain endroict d'Africque.* Amsterdam, chez Cornille Claesson, 100 p. [Les éditions Chapitre.com, 2017]

Garrard T. F., 1980. *Akan weights and the gold trade.* Legon history series. London, Longman, 393 p.

Mollat H., 2003. A new look at the akan gold weights of west Africa. *Anthropos*, 98: 31-40.

Niangoran-Bouah G., 1984-1987. *L'univers Akan des poids à peser l'or.* Dakar, Nouvelles Éditions Africaines, 3 vol. (Vol. I: Les poids non figuratifs, 1984, 316 p.; vol. II: Les poids figuratifs, 1985, 320 p.; vol. III: Les poids dans la société, 1987, 328 p.

Ott A., 1968. Akan gold weights. *Transactions of the Historical Society of Ghana*, 9: 17-42.

Traoré K. & Bednarz N., 2008. Mathématiques construites en contexte : une analyse du système de numération oral utilisé par les Siamous au Burkina Faso. *Nordic Journal of African Studies*, 17(3): 175–197.

Zeller R., 1913. *Die goldgewichte von Asante (westafrika) eine ethnologische Studie*. Leipzig, Teubner ed, 77 p.

ETHNOLOGIE

Annexes

Annex 1: The different akan numerations (Bowdich, 1819)

APPENDIX. No. VI.

	1. *Inta.*	2. *Booroom.*	3. *Ashantee.*	4. *Aöwin.*	5. *Amanaheä.*
One(*a*)	Koko	Ekoo	Akoon	Aconë	Aconë
Two(*b*)	Anyoe	Enoo	Anoo	Enyow	Enyow
Three(*c*)	Assa	Essa	Mensa	Inza	Insa
Four(*d*)	Anna	Enna	Ennung	Inna	Enna
Five(*e*)	Annoo	Annoo	Ennoom	Noo	Enoo
Six(*f*)	Assee	Esseä	Inseä	Inzeah	Inseah
Seven(*g*)	Assoonno	Assoono	Inshong	Inzoo	Insoon
Eight(*h*)	Adoobrooa	Aquiay	Woquee	Motteä	Mottuay
Nine	Digrakoono	Akonno	Oonkounong	Ongoona	Ongona
Ten(*i*)	Koodoo	Edoo	Edoo	Boloo	Booloo

	6. *Ahanta*	7. *Fantee*	8. *Affootoo*	9. *Inkran*†	10. *Adampë*
One	Akoon	Akoor	Achoomee	Ekkoo	Kakee
Two	Ayue	Abeeën	Ennuë	Ennuë	
Three	Assan	Abiasseh	Assah	Ettayh	
Four	Arra	Anan	Annah	Edjuë	
Five	Aoonoo	Ennoom	Ennoo	Ennoomó	
Six	Ayshing	Asseeä	Isshin	Eghpah	
Seven	Assooa	Ashong	Isshennooh	Paghwooh	
Eight	Awotchay	Awotwee	Ettchee	Paghnue	
Nine	Awonna	Akoon	Assan	Nahoon	
Ten	Boonoo	Edoo	Eddoo	Nongmah	

Bowdich page 503-504-505

Annex 2: Zeller's table IV

TABELLE IV.

DAS GEWICHTSYSTEM

ergänzt durch die Gewichtstypen von Müller (1776), Bellom (1872) und Christaller (1881).

Reihe I.

$^1/_2$ *Pẹsẹwa* = 1 *Pọwa*
1 *Pẹsẹwa* = 1 *Pẹsẹwa*
2 *Pẹsawa* = 1 *Damma*
4 *Pẹsẹwa* = 1 *Kọkọa.*

Reihe II.

3 *Pẹsẹwa* = *Takufã*
6 *Pẹsẹwa* = 1 *Tàkú*
12 *Pẹsẹwa* = 2 *Tàkú*
24 *Pẹsẹwa* = 4 *Tàkú*
8 *Tàkú* = 1 Ak. *Agyiratŵefã*
16 *Tàkú* = 1 Ak. *Agyiratŵe*
32 *Tàkú* = 1 Ak. *Dwowasuru*
64 *Tàkú* = 1 Ak. *Dŵowa*
128 *Tàkú* = 1 *Nn̈wowa mmienu*
$\boxed{256\ \textit{Tàkú} = 1\ \textit{Bẹnnā}}$
512 *Tàkú* = ?
1024 *Tàkú* = 1 *Bẹnnā anaṅ*
2048 *Tàkú* = *Bẹnnā awotŵe.*

Reihe III.

3 *Tàkú* = 1 *Asẹ*
6 *Tàkú* = 1 *Sọwafã*
12 *Tàkú* = 1 *Sọwa*
24 *Tàkú* = 1 As. *Nsãno*
48 *Tàkú* = 1 As. *Asĩa*
96 *Tàkú* = 1 ?
192 *Tàkú* = 1 *Egwa abiessan.*

Reihe IV.

5 *Tàkú* = 1 ?
10 *Tàkú* = 1 Ak. *Bọdọmmofã*
20 *Tàkú* = 1 Ak. *Bọdọmmó*
40 *Tàkú* = 1 Ak. *Peresuru*
80 *Tàkú* = 1 ?
160 *Tàkú* = 1 *Nn̈wowa mmienu né dŵowasuru.*

Reihe V.

7 *Tàkú* = 1 As. *Dọmmafã*
14 *Tàkú* = 1 As. *Dọmma*
28 *Tàkú* = 1 As. *Dwowasuru*
56 *Tàkú* = 1 As. *Dŵowa.*

Reihe VI.

9 *Tàkú* = 1 Ak. *Dọmmafã*
18 *Tàkú* = 1 Ak. *Dọmma*
36 *Tàkú* = 1 *Súrú*
72 *Tàkú* = 1 *Osŭā* = 2 *Súrú*
144 *Tàkú* = 1 *Asŭānú* = 4 *Súrú*
288 *Tàkú* = 1 *Peredŵane* = 8 *Súru*
576 *Tàkú* = 1 *Ntānu* = 16 *Súrú.*

Reihe VIa.

216 *Tàkú* = 1 *Asŭāsā* = 6 *Súrú*
432 *Tàkú* = 1 *Tasŭānu* = 12 *Súrú*
864 *Tàkú* = 1 *Ntāsã* = 24 *Súrú.*

Reihe VIb.

360 *Tàkú* = 1 *Tōsŭā* = 10 *Súrú*
720 *Tàkú* = 1 *Ntānu asŭānu* = 20 *Súrú.*

Reihe VII.

11 *Tàkú* = 1 As. *Bọdọmmofã*
22 *Tàkú* = 1 As. *Bọdọmmó*
44 *Tàkú* = 1 *Takimansua.*

Reihe VIII.

$6^1/_2$ *Tàkú* = 1 *Fiasofã*
13 *Tàkú* = 1 *Fiáso*
26 *Tàkú* = 1 *Nsãno.*

Annex 3: The four Garrard's series

EVOLUTION OF THE AKAN WEIGHT-SYSTEM

ISLAMIC MITKAL SERIES

½ dirhem	1.4 grams	(*Soafa*. Equals ⅓ *mitkal*)
1 dirhem	2.9	(*Soa*).
2 dirhems	5.8	(*Nsano* or *nsoanu* = 2 *soa*. This weight is duplicated in the troy series: see below).
½ mitkal	2.2	
1 mitkal	4.4	
2 mitkals	8.8	
4 mitkals	17.6	
8 mitkals	35.2	
16 mitkals	70.4	
20 mitkals	88.0	
32 mitkals	141	
40 mitkals	176	
48 mitkals	211	(Equals 8 Islamic ounces: see below).
64 mitkals	282	
80 mitkals	352	(One *ratl* of Islamic weight).

ISLAMIC OUNCE STANDARD

1/16 ounce	1.65 grams	
3/32 ounce	2.5	
⅛ ounce	3.3	
3/16 ounce	4.9	
¼ ounce	6.6	
⅜ ounce	9.9	
½ ounce	13.2	
¾ ounce	19.8	
1 ounce	26.4	(One *uqiya*)

ISLAMIC OUNCE STANDARD

1½ ounces	39.6
2 ounces	52.8
3 ounces	79.2
4 ounces	106
6 ounces	158
8 ounces	211
10 ounces	264
12 ounces	317
15 ounces	396
20 ounces	528
60 ounces	1584

EUROPEAN OUNCE STANDARDS

	Portuguese	*Troy*
1/16 ounce	1.8	1.95
⅛ ounce	3.6	3.9
3/16 ounce	5.4	5.8
¼ ounce	7.2	7.8
⅜ ounce	10.8	11.7
½ ounce	14.3	15.6
¾ ounce	21.5	23.4
1 ounce	28.7	31.1
1½ ounces	43.0	46.7
2 ounces	57.4	62.2
4 ounces	115	124
8 ounces	230	249
12 ounces		373
24 ounces		747
60 ounces		1866

According to Garrard, p. 240-241.

Annex 4: Ashanti and Akyem weight lists according to Garrard

£	s	d	Akyem	Asante	taku	poids
		1	pesewa	pesewa		0
		2	damma	damma		0
		3	takufa	takufa	0,5	0,11
		4	kokoa	.		0
		4,5	.	kokoa		0
		6	taku	takufa	1	0,22
		9	.	kokoa no	1,5	0,33
	1		.	takuno	2	0,44
	1	6	.	takunsa	3	0,66
	2		.	takunan	4	0,88
	2	6	.	takunun	5	1,1
	3		soafa	soafa	6	1,32
	3	3	fiasofa	.	6,5	1,43
	3	6	.	dommafa	7	1,54
	4		dommafa	borofofa	8	1,76
	4	6	.	agiraotwefa	9	1,98
	5		.	nsonsafa	10	2,2
	5	6	.	bodommofa	11	2,42
	6		soa	soafa	12	2,64
	6	6	fiaso	.	13	2,86
	7		.	domma	14	3,08
	8		domma	borofo	16	3,52
	9		agiratwe	agiratwe	18	3,96
	10		nsonsa	nsonsa	20	4,4
	11		.	bodommo	22	4,84
	12		.	nnomano	24	5,28
	13		nsano	nsano	26	5,72
	15		.	dwoasuru	30	6,6
	16		nnomano	namfisuru	32	7,04
	17		.	bremanansuru	34	7,48
	18		dwoasuru	.	36	7,92

£	s	d	Akyem	Asante	taku	poids
1			suru	surupa	40	8,8
1	2		.	peresuru	44	9,68
1	3	6	.	techimansua	47	10,34
1	4		suru ne dommafa	.	48	10,56
1	6		.	asia	52	11,44
1	10		asia	dwoa	60	13,2
1	12		.	namfi	64	14,08
1	16		dwoa	onansua	72	15,84
2			osua	osua pa	80	17,6
2	7		.	osua ne domma	94	20,68
2	8		osua ne domma	.	96	21,12
3			osua ne suru	osua ne suru	120	26,4
3	12		dwoano	.	144	31,68
4			osuano	osuano	160	35,2
4	13		.	osuano ne nsano	186	40,92
4	18		osuano ne dwoasuru	.	196	43,12
5			.	osuano ne suru	200	44
6			osuansa	osuansa	240	52,8
7			benna	benna	280	61,6
8			pereguan (nta)	pereguan (nta)	320	70,4
9	6		.	perguan asia	372	81,84
9	10		pereguan asia	.	380	83,6
12			tasuano	.	480	105,6
16			ntano	pereguan no	640	140,8
18	12		.	perguan no asia no	744	163,68
24			ntansa	ntansa	960	211,2
32			.	pereguan nan	1280	281,6
40			.	pereguan nun	1600	352

Akyem and Ashanti Appellations, according to Garrard, p. 347-349. Based on 3 £ 12 s for one Ozt.
The numeric suffixes have been standardized according to **table 1**.

Annex 5: Agni appellations for gold, according to Binger

Dans les factoreries, on se sert de l'once de 32 grammes (96 francs or) et de ses subdivisions pour les affaires que l'on traite en or.

Chaque once vaut 16 *ackés* à 6 francs.

Chaque acké vaut 12 *takou* à 50 centimes.

Voici les appellations agni pour l'or :

Pouassaba (commun aux Mandé), valeur décomptée à 3 francs le gramme	0f125
Damma (commun aux Mandé)	0 25
Dé, égal au banankili mandé, ou takou (au pluriel *dé* se dit *ba*)	0 50
Dé n'damma	0 75
Bâa (ne pas confondre avec le *ba* court, pluriel de *dé*)	1 »
Bâa n'damma	1 25
Ba san (*ba* pluriel de *dé* ; *san*, trois)	1 50
Ba na (4)	2f »
Ba nou (5)	2 50
Ba sien (6)	3 »
Ba nso (7)	3 50
Ba mokué (8 fois 50 centimes)	4 »
Ba ngouna	4 50
Ba bourou	5 »
Ba bourou n'takou (0,50 × 10 + 0,50) = 5,50	5 50
Méttéba ou Méttéva ou 1 acké	6 »
Mettéba n'takou	6 50
Njunia	7 »
Mokué	8 »
Essoba	9 »
Nzonzan	10 »
Nzonzan bâa	11 »
Zamalfan (moitié)	12 »
Enzouazan	13 »
Enzouazan bâa (terme peu usité et chiffre peu employé par superstition)	14 »
Tuabo	15 »
Nzarazué ou encore : tuabo ani ba san	16 50
Bandézui	18 »
Anu zui	19 »
Taraé	21 »
Zémaré	24 »
Baré	27 »
Essan (ce devrait être : nzonzan essan, l'usage a fait tomber le premier terme)	30 »
Bagoua n'déa	33 »
Étéa	36 »
Anrué ou anrui	39 »
N'dua	42 »
N'dua (ni) ba sien (42 + 3)	45 »
Anraé (demi-once, le barifiri des Mandé)	48 »
Etté sui	54 »
Assé nua (essan nua ou 30 × 2)	60 »
Bagoua ndé nua (33 × 2)	66 »
Ba ndéa	72 »
Anumia	78 »
Ndua niua (42 × 2)	84 »
Ndua niua mettéba (42 × 2 + 6)	90 »
Anra niua (48 × 2) (1 once)	96 »
Anra niua mettéba (48 × 2 + 6)	102 »
Attatué	108 »
Anrué san (39 × 3)	117 »
Ndua san (42 × 3)	126 »
Anra san (48 × 3)	144 »
Ta	162 »
Banna (2 onces) (96 × 2)	192 »
Banna (suivi d'un autre chiffre qui le multiplie, banna n'est plus qu'une once ; ainsi, dans le chiffre suivant : *banna ani niua*, c'est comme si l'on disait 1 once + 2 = 3 onces)	288 »
Anra niua bourou, ce qui revient à dire 1 once 10 fois = 10 onces ou	960 »

Annex 6: Abel's table.

1° Série des *ba* :

kpesseba	1/2 graine (*abrus precatorius*)	*ba-n'san*	3 *ba*	*ba-n'gunan*	9 *ba*
dama	1 graine	*ba-nan*	4 *ba*	*ba-buru*	10 *ba*
degn ou *ba*	2 graines	*ba-nu*	5 *ba*	*n'zié-nyon*	12 *ba*
taku	3 graines	*ba-zien*	6 *ba*	*n'zu-nyon*	14 *ba*
ba-nyon	2 *ba*	*ba-zu*	7 *ba*	*mokué-nyon*	16 *ba*
		ba-mokué	8 *ba*	*n'zié-nsan*	18 *ba*

2° Séries Principales :

assan		*gbangbandya*		*tya*		*anui*		*gua*		*anan*		*tya-sué*	
série f	*série m*	*série f*	*série m*	*série f*	*série m*	*série f*	*série m*	*série f*	*série m*	*série f*	*série m*	*série f*	*série m*
								méteba					
									12 *ba* 8 *t* 1,77 g				
mokué-nyon		*n'zié-nsan*		*assoba*		*n'zu-n'san*		*mokué-n'san*		*simbari-fan*		*n'zuanzan*	
16 *ba* 10 1/2 *t* 2,36 g	11 *t* 2,44 g		18 *ba* 12 *t* 2,66 g	19 1/2 *ba* 13 *t* 2,88 g	20 *ba* 13 1/2 *t* 2,99 g	21 *ba* 14 *t* 3,10 g	14 1/2 *t* 3,21 g	23 *ba* 15 1/2 *t* 3,44 g	24 1/2 *ba* 16 *t* 3,55 g	27 *ba* 18 *t* 3,99 g	28 1/2 *ba* 19 *t* 4,21 g	19 1/2 *t* 4,32 g	20 1/4 *t* 4,49 g
kuabo		*n'darasué*		*bandya-sué*		*anui-sué*		*tra*		*simbari*		*bari*	
31 1/2 *ba* 21 *t* 4,66 g	33 *ba* 22 *t* 4,88 g	34 1/2 *ba* 23*t* 5,10 g	36 *ba* 24 *t* 5,32 g	39 *ba* 26 *t* 5,77 g	40 1/2 *ba* 27 *t* 5,99 g	42 *ba* 28 *t* 6,21 g	43 1/2 *ba* 29 *t* 6,43 g	46 *ba* 32 *t* 7,10 g	48 *ba* 34 *t* 7,54 g	54 *ba* 36 *t* 7,99 g	57 *ba* 38 *t* 8,43 g	58 1/2 *ba* 39 *t* 8,65 g	60 3/4 *ba* 40 1/2 *t* 8,99 g
assan		*gbangbandya*		*tya*		*anui*		*gua*		*anan*		*tya-sué*	
63 *ba* 42 *t* 9,32 g	66 *ba* 44 *t* 9,76 g	69 *ba* 46 *t* 10,21 g	72 *ba* 48 *t* 10,65 g	78 *ba* 52 *t* 11,54 g	81 *ba* 54 *t* 11,98 g	84 *ba* 56 *t* 12,43 g	87 *ba* 58 *t* 12,86 g	92 *ba* 62 *t* 13,76 g	96 *ba* 64 *t* 14,20 g	108 *ba* 72 *t* 15,98 g	114 *ba* 76 *t* 16,87 g	117 *ba* 78 *t* 17,31 g	121 1/2 *ba* 81 *t* 17,98 g
assan-nyon		*gbangbd.-nyon*		*bandya-nyon*		*anui-nyon*		*gua-nyon*		*anan-nyon*		*atakpi*	
126 *ba* 84 *t* 18,64 g	132 *ba* 88 *t* 19,52 g	138 *ba* 92 *t* 20,42 g	144 *ba* 96 *t* 21,30 g	156 *ba* 104 *t* 23,08 g	162 *ba* 108 *t* 23,96 g	168 *ba* 112 *t* 24,86 g	174 *ba* 116 *t* 25,72 g	184 *ba* 124 *t* 27,52 g	192 *ba* 128 *t* 28,40 g	216 *ba* 144 *t* 31,96 g	228 *ba* 152 *t* 33,74 g	234 *ba* 156 *t* 34,62 g	243 *ba* 162 *t* 35,96 g
						anui-n'san		*gua-n'san*		*anan-n'san*		*ta*	
						252 *ba* 168 *t* 37,29 g	261 *ba* 174 *t* 38,58 g	276 *ba* 180 *t* 41,88 g	288 *ba* 192 *t* 42,60 g	324 *ba* 216 *t* 47,94 g	342 *ba* 228 *t* 50,61 g	351 *ba* 234 *t* 51,93 g	364 1/2 *ba* 243 *t* 53,94 g
						ta		*benda*		*banna*		*péréguan*	
							348 *ba* 232 *t* 51,44 g	362 *ba* 248 *t* 55,04 g	384 *ba* 256 *t* 56,80 g	432 *ba* 288 *t* 63,92 g	456 *ba* 312 *t* 67,48 g	468 *ba* 312 *t* 69,24g	486 *ba* 324 *t* 71,92 g

Weight appellations are Baule. This table is complicated by the presence of male (m series) and female (f series) values, the difference between which is too small to be operative. It is also wobbly because Abel dos not take as base units 1,3,5... 13 *taku*, but intermediate values, those whose names would have been the most used, with their multiples and sub-multiples. This gives an irregular progression, passing in *taku* from a reason 6 to a reason 8 as follows: 42 (*assan*), 48 (*gbangbandya*), 52 (*tya*), 56 (*anui*), 64 (*gua*), 72 (*anan*), 80 (*tyasué*). In addition, these weights should not be on the same line because they are not multiple from each other.

The table becomes coherent again, when it is reconstructed in *ba*, taking as base units 1, 3, 5... 13 *ba* and changing the order of the columns (**Table 5**). In *ba* rather than in *taku*, because the names of several weights in the first line show that they are multiples of *ba* (*mokué-nyon* = 16, *n'zié-nsan* = 18, *n'zu n'san* = 21, *mokué n'san* = 24.

Annex 7: Akan Multiplication Table

Akan Multiplication Table							
Serie	**S1**	**S3**	**S5**	**S7**	**S9**	**S11**	**S13**
1	**1**	**3**	**5**	**7**	**9**	**11**	**13**
2	**2**	**6**	**10**	**14**	**18**	**22**	**26**
3	(3)	(9)	**15**	**21**	**27**	**33**	**39**
4	**4**	**12**	**20**	**28**	**36**	**44**	**52**
6	(6)	(18)	**30**	**42**	**54**	**66**	**78**
8	**8**	**24**	**40**	**56**	**72**	**88**	**104**
12	(12)	(36)	**60**	**84**	**108**	**132**	**156**
16	**16**	**48**	**80**	**112**	**144**	**176**	**208**
24	(24)	(72)	**120**	**168**	**216**	**264**	**312**
32	**32**	**96**	**160**	**224**	**288**	**352**	**416**
48	(48)	(144)	**240**	**336**	**432**	**528**	**624**
64	**64**	**192**	**320**	**448**	**576**	**704**	**832**
96	(96)	(288)	**480**	**672**	**864**	**1056**	**1248**
128	**128**	**384**	**640**	**896**	**1152**	**1408**	**1664**
192	(192)	(576)	**960**	**1344**	**1728**	**2112**	**2496**
256	**256**	**768**	**1280**	**1792**	**2304**	**2816**	**3328**
384	(384)	(1152)	**1920**	**2688**	**3456**	**4284**	**4992**
512	**512**	**1536**	**2560**	**3584**	**4608**	**5632**	
768	(768)	(2304)	**3840**	**5376**	**6912**		
1024	**1024**	**3072**	**5120**	**7168**			
1536	(1536)	(4608)	**7680**				
2048	**2048**	**6144**					
4096	**4096**						