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Posthumous Essay

This essay is a preliminary effort in outlining a history of mathematics in the Philippines. It calls attention to the existence of a highly developed enumeration and arithmetical system prior to the Spanish conquest, and argues that this enumeration system had unique characteristics that distinguished it from other Southeast Asian societies. Other mathematical and scientific ideas, such as the use of geometric concepts and astronomical tools, in the preconquest Philippines are also discussed and presented.

KEYWORDS: ETHNOMATHEMATICS · PRECONQUEST SOCIETIES · INDIGENOUS CULTURE · HISTORIOGRAPHY

I represent a people that is little known to you. Today we are lost to civilization in the far reaches of the eastern seas. We have no government of our own, we have no flag—but we have a soul, a proud cultural heritage of our ancient Tagala race, and even now after three centuries of Spanish assimilation it is struggling for light and expression.
– Juan Luna, 1897

A Filipino reading Sir Isaac Newton's *Principia mathematica* (1934, 440) experiences a most pleasant surprise upon encountering an explicit reference to the Philippines in this seventeenth-century classic of mathematics and science:

> [The waters in the Gulf of Tonkin] flow and ebb, not twice, as in other ports, but once only every day; . . . There are two inlets to this port and the neighboring channels, one from the seas of *China*, between the continent and the island of *Leuconia*; the other from the *Indian* sea, between the continent and the island of *Borneo* . . .

The quote is found in Proposition XXIV, Theorem XIX of his *Principia* and forms part of one of Newton's many elaborations of the theory of gravitation. The context of the quote is Newton's development of the observations of Edmund Halley, the famous astronomer and benefactor of Newton, concerning the effects of the gravitational pull of the moon on the ebb and flow of the tides along the equator and its significance for the theory of wave interference. The reference to the Philippines is done through the mention of Leuconia, the ancient Ptolemaic name for the Philippines.

While the mention of the Philippines was through the indirectness of a mere obiter, clearly given to merely illustrate a scientific theory, the citation is still intriguing enough to lead one to the historical obverse and to inquire into the state of mathematics and the sciences in the Philippines while Newton was writing his magnum opus and developing the calculus and classical mechanics. This essay then concerns itself not with the mechanics of the rise and fall of the tides but with the historical ebb and flow of ideas on the side of the globe farthest from Newton as he was hewing his celestial mechanics within the ivied halls of Trinity College in Cambridge.

Status Questionis

The greatest difficulty in attempting a history of mathematics or of mathematical thinking in the Philippines is the absence of sources. There is nothing written on the topic. The accepted standard texts of the history of mathematics such as those by Kline,[1] Eves,[2] and others, while providing generous space to mathematical developments in the "non–Western" world, do not make even the slightest mention of the Philippines. On the other hand, the thousands of texts written on Philippine history since the 16th century are analogously deficient in that they concentrate on political, economic, social, institutional, or regional history, completely neglecting the history of mathematics or even of science in the Philippines as a separate and important area of concern.

This gaping lacuna leads one to almost fall into the temptation to classify the Philippines as one of the histories or cultures which Morris Kline, the dean of the history of mathematics, describes as non-mathematical:

> As we examine the early civilizations, one remarkable fact emerges immediately. Though there have been hundreds of civilizations, many with great art, literature, philosophy, religion, and social institutions, very few possessed any mathematics worth talking about. Most of the civilizations hardly got past the stage of being able to count to five or ten.[3]

The temptation easily becomes a sin of commission when one accepts at face value some of the judgments made by Spanish friars about the Filipino's lack of capacity for mathematics and science in the chronicles of early Philippine society. Fray Gaspar de San Agustin, for example, publishing his *Compendio del arte de la lengua tagala* (*Compendium of the Art of the Tagalog Language*) in 1703 wrote that ". . . los tagalos son poco aritméticos"[4]—the Tagalogs are little suited for mathematics, following this judgment with a harsher evaluation two pages later, "Pero los tagalos en el contar son varios y malos aritméticos"—Tagalogs in counting are unreliable and bad mathematicians."[5] One Fray Eladio Zamora, another Agustinian friar like Gaspar de San Agustin, supports the view of his predecessor by making a similar claim about the seventeenth- and eighteenth-century Filipino in his survey of education in the eighteenth-century Philippines, citing ". . .

the small capacity of the [*indio*] for the sciences . . ."[6] The Spanish friar chroniclers, moreover, were not alone in this view but were concurred with by many Spanish secular historians who also believed in the then-prevailing caricature that the *indio* was not only indolent and vice-ridden but was also a beast of burden who possessed the most minimal of intellectual skills. One such opinion directly relating to our present concern is the view expressed by Vicente Barrantes who stated in 1869 that "The indios learn to reckon with great difficulty. They generally take shells or stones to help them, which they heap up and count."[7]

It is clear that an attempt to do a history of mathematics and science in the Philippines, especially one that concentrates on the period where traditional Philippine society experiences a profound transformation as it interacts with Spanish colonialism, cannot productively proceed from these premises.

The Algebra of the Weaving Patterns, Gong Music, and Kinship System of the Kankana-ey of Mountain Province (1996), a short yet most important book published by a group of mathematicians from the University of the Philippines in Baguio, proceeds from a different perspective about mathematics and society and provides a set of premises which permits us to explore the history of mathematics in the Philippines in a more productive manner. The book focuses on three areas in the life of the Kankana-ey, one of seven principal linguistic groups in the Cordillera region in Northern Philippines—traditional weaving, indigenous gong music, and customary kinship patterns—and successfully shows that abstract mathematical ideas and principles such as geometric transformations and algebraic structures like frieze groups are "imbedded" in these indigenous practices.

The present study starts from the premise that mathematical principles are indeed imbedded in the practices of society and that the absence of a history of mathematics in the Philippines is less attributable to the inherent incapacity of a people for mathematical and scientific abstraction than to the negligence of mathematicians and historians in abstracting, formalizing, and documenting these principles. The present work is a preliminary effort in outlining a history of mathematics in the Philippines. It attempts to call attention to the presence of a relatively developed set of mathematical ideas in early Philippine society. It will establish that a highly developed enumeration and arithmetical system was already developed by the time of the Spanish conquest and that this enumeration system had unique characteristics which distinguished it from its other Southeast Asian neighbors. Other mathematical

and scientific ideas such as the use of geometric concepts and astronomical tools in early Philippine society will also be discussed and presented.

The Nebulous Roots

Traces of mathematical ideas can be found even in the earliest moments of Philippine society which have been hitherto recorded.

Basic geometric ideas, albeit in rudimentary form, are found in periods as early as the Angono Petroglyphs, the set of prehistoric rock and cave drawings found in the hills of Angono, a mountainous area south of Manila which juts from the Cordillera mountain range and extends to Laguna de Bay, the largest lake in Asia. Anthropologists who have studied the Angono Petroglyphs have found it difficult to date the rock drawings with precision but conjecture that they probably date to the late Neolithic Period or 3,000 years B.C. since the artifacts excavated from the area come from that time. Jesus Peralta, the most seasoned anthropologist from the National Museum, describes the petroglyphs:

> As a general rule the drawings are of human figures, consisting of line incisions of circular or domelike heads with or without necks set on a rectangular or V–shaped body. The arms, sometimes with digits, and the legs are also lineally executed, and are usually flexed. An inventory of the drawings produced a total of 127 figures clearly discernible as integral units. This count excludes other incisions that comprise slashes, naturally occurring holes, scratches, pits, pockmarks and other surface alterations on the rockwall.
>
> Some incisions on the rockwall can be recognized: triangles, rectangles, and circles. There is a high degree of probability that the triangles drawn singly have sexual connotations. These triangles are more or less equilateral, standing on an angle with a short line bisecting this angle. There is a complex of 4 triangles forming a parallelogram. One rectangle stands on one short side. Other nonfigurative cuts appear on the wall. A set of four parallel horizontal lines are unequal in length. There is also a set of five lines radiating from a common center.[8]

The prehistoric figures, furthermore, demonstrate that the Neolithic artists intuitively knew how to work with the notions of symmetry and proportion since the rock and cave drawings show a respect for the basic mathematical and aesthetical ideas of symmetry and proportion, as well as the more complicated idea of mathematical scaling, as seen in the successful resizing of the stone etchings from the actual, bigger figures of men and animals they represent.

The drawings, more significantly, evidence the important capability of abstraction. The Angono Petroglyphs use simple lines to draw their figures, implying a more abstract approach to the subject matter, in contrast to their counterparts in European prehistoric lithic art, as for example the drawings in Altamira, where the animals drawn on the cave walls have a more realistic character. The Neolithic artists of Angono used lines to draw the figures which represented themselves and other members of their community, implying at least three different levels of abstraction:

- the abstraction necessary to draw and properly utilize a line;
- the abstraction shown in using a line to depict a figure; and
- the abstraction required to see that the figures drawn represent the artists and the members of their community.

This tendency to represent artistic ideas in relatively abstract terms can still be found in the art of many actual indigenous Filipino communities. The different tribes in the northern Cordillera region, for example, have preserved this tendency towards abstraction, as seen for example in their depiction of their religious icons such as *anitos* and *bululs* which are carved in wood with an abstract or even "modern" character, even if the artistic and religious traditions date back to the prehistoric and almost nebulous past. Much of the art from these very same northern Cordillera communities also exhibit this tendency towards the abstract, as seen for example in the foldable stools and three-legged tables they produce from a single piece of wood. In the case of the table, three legs are fashioned from a single piece of log but are cut in such a way that they still form a single piece of wood. The legs can be made to open as an expandable tripod when necessary but can be collapsed back into the single log when desired, the joins between the three legs executed through a series of intricate holes to permit the three legs to collapse and expand as needed, all carefully carved so that the three legs do not dissociate from the original log. The design, presumably of a most ancient origin, employs, not in Escher-like drawings or as computer simulation, but in an actual three-dimensional wood carving, the most complicated contortions possible of Moebius strips and other advanced ideas of topology.

Another equally impressive demonstration of geometric thinking in ancient Philippine society can be found in the practice of shipbuilding. Not only were the mastery of the concepts of convexity, concavity, and the proper proportion between ship breadth and length to ensure sailing efficiency demonstrated, but more significant to note was the practice of constructing ships and boats to fit inside each other, with as much as twelve ships all fitting inside each other, exactly in the same manner as Russian dolls contain each other, an impressive demonstration, in gigantic three dimensional wooden models, of the mathematical ideas of sets, subsets, the measurement of volumes, and ordinality. Fr. Francisco Colin, a Jesuit priest who was amongst the first Spanish religious chroniclers who wrote about early Philippine society, recorded the practice in Catanduanes in his 1663 *Labor evangelica:*

> They were shipbuilders by profession. They made a great quantity of very light craft, which they took for sale throughout the region in a very curious way, very much like the nests of boxes they make in Flanders. They built a large vessel, undecked, without using either nails or futtock timbers; then they built a smaller vessel which fitted exactly inside the first; then a third which fitted exactly inside the second; and so on, so that a large biroco might in the end have ten or twelve other vessels inside it of four specific types which they called biroco, virey, barangay and binitan. When they reach a port where they hope to make a sale—and they go as far as Calilaya, Balayan, Mindoro and other places more than a hundred leagues from their shipyards—they take out the smallest vessel and then the rest in order, so that he who saw but one ship enter the harbor would in an hour be puzzled to see ten or more craft in the water.[9]

The ancient Filipino institution of debt and usury reveals yet another instance of mathematical thinking. The universally accepted means of exchange and store of value in ancient Philippine society was not money but rice, the staple food. Debts were therefore incurred through this commodity. Repayment of the debt was expected to be accompanied with interest since rice was not only immediate food but was also seed, or capital, used in planting to produce more rice. The payment of interest represented the alternative cost of rice or the benefits forgone during the period the rice was on loan. The Tagalog term for interest, *tubo*, or growth, captures precisely the roots of the practice in the system of planting and harvesting rice. The amount of interest or *tubo* to be charged is directly related to the potential harvest. Miguel de Loarca, one of the earliest Spanish colonizers, describes the exact manner how interest was computed:

> If one lends another rice and a year passes without the debt being paid, since rice is something that is planted, if it is not repaid in the first year of sowing, double the amount of the loan must be paid in the second year, and four times the third, and so on at this rate. This alone is their way of taking interest. Some indeed give a different account of it, but they have not well understood the matter. . .[10]

Interest grew not through simple arithmetical accretion but was doubled every harvest time. It was conceived of as a function of the productive value of rice used as capital or seed. An implicit distinction was made in this practice between simple arithmetical growth and exponential growth, the latter explicitly related to organic growth and the core insight behind what we now know as the exponential function. While admittedly we do not have here specific mathematical techniques of the exponential function that permit us to describe intricacies of beta particle decay or the dynamics of population growth, the idea that something grows not just arithmetically but geometrically, by compounding interest over the different harvest seasons, implicitly seeing a relationship between organic growth and interest payments, demonstrates an ability to perceive abstract mathematical relationships and utilize these patterns in everyday life.

The recently discovered Laguna Copperplate Inscription (LCI), hitherto the earliest document or artefact relating to early Philippine society which, as a precise date, also reveals the use of mathematics in the ancient history of the country. The LCI, recorded during the equivalent of the last year of ninth century A.D., is a formal legal document engraved on a copper plate absolving a nobleman and his family of debts. The LCI, written in an ancient Malay language connected to Sanskrit, Old Malay and Old Tagalog, was inscribed on the plate using the Old Kawi script, the ancient system of writing descended from different variants of Sanskrit, which was in wide use throughout Southeast Asia, extending from Bali through Thailand and Vietnam, during the tenth century, forming the basis of the different writing systems of these societies. The LCI is significant for many reasons,[11] but for our present purposes it is important to point out that the document uses the Saka calendar system, permitting us to count and mark the years, and also shows a precise measurement for gold, implying the use of a standard system of weights and measures. The LCI also refers to the phases of the moon to fix the precise day within the month, implying familiarity with basic concepts of astronomy. A less technical translation of the LCI reads

> In the Saka-year 882 (A.D. 900) in the month of March-April on the fourth day of the dark half of the moon which is a Monday, Lady Angkatan, with her child Bukah, she the wife of His Honor Namwran, appeared before the Chief and Commander of Tundun (Tondo) and Scribe. Upon the instruction of the Chief and Commander of Tundun, Jayadewa, a former chief of Pailah, a legal document was recorded clearing Namwran of a debt in gold amounting to 1 *kati* and 8 *suwarna* (around 926.4 grams). The debt was owed the Chief of Dewata representing the Chief of Mdang. Witnessing the legal ceremony were the Leader of Puliran (Pulilan), Kasumuran; the Leader of Pailah, Ganasakti, and the Leader of Binwangan, Bisruta. . . .[12]

The Cosmology of the Plebe

The system of reckoning the years and the related astronomical work can be assumed to have continued into the early sixteenth century since Spanish conquistadores and chroniclers have recorded aspects of such practices when they arrived, with some accounts suffering from the attempt to read the Western calendar method in the peculiar manner early Filipinos practiced astronomy and counted time.

One such misinterpretation was made by Fr. Francisco lgnacio Alcina, a Spanish missionary writing during the second half of the seventeenth century, who characterized the early Visayans with the most colorful description of *plebe imperita* or plebians without skill since the cosmological and scientific practices of these ancient Filipinos did not exactly coincide with Alcina's own.

Juan Francisco de San Antonio, a Franciscan missionary, provides a more sympathetic account in his *Cronicas*, written in 1738, where he describes the difference in the approach of the early Filipinos in the way they marked time and fashioned their cosmology:

> It is not known whether these natives divided the time in hours, days, weeks, months, or years, or made any other division of time. As this was necessary to them for the reckoning of their commerce, trade, and contracts (in which they all engaged), they used for reckoning their times of payment, and for other transactions and business of their government—for the hours, the state of the sun in the sky, the crowing of the cock, and the laying time of the hens, and several other enigmas which are still employed in the Tagálog speech. To keep account of the changing of seasons, they knew when it was winter or summer by the trees, and their leaves and fruit. They knew of the division into months or years by moons. Consequently, in order to designate the date of payment, they said "in so many moons, in so many harvests, or in so many fruiting's of such and such a tree." These were the methods employed in their trading and government.[13]

This cosmology was certainly different from the paradigm used by Tycho Brahe, Johannes Kepler, and Newton in fixing the position of the stars and developing celestial mechanics. It was an approach more akin to the ancient Greek concept of *kairos* which viewed time in terms of subjective moments rather than *kronos* or the strictly measureable time which can be sliced into the most minute part with the help of a digital watch.[14] This approach to the marking of time of course was not necessarily less valid than one based on the positivistic attitudes in Europe during the eighteenth and nineteenth centuries, for this cosmology of the *plebe imperita* also had its notions of regularity and periodicity and had served adequately the needs of its users. The eminent Filipino scholar Pedro Serrano Laktaw, writing in his posthumously published classic *Estudios gramaticales sobre la lengua tagálog*, has only but praises for ancient Filipino methods of telling time:

> Es sobremanera original y curiosa la distribución del tiempo que practicaba nuestro pueblo antes de llegar a la actual civilización. No conociendo aún el reloj, se gobemaba en esto por lo que en los astros observaba, en los animales y plantas veía, y notaba en sus mismas naturales acciones.

> It was exceptionally original and interesting how our people divided time before the present civilization. Not yet knowing the watch, they managed time through what they observed in the stars, in what they saw in the plants and animals, and what they noted in their natural movements.[15]

Let us then take a closer look at how time was conceived and reckoned in ancient Philippine society.

Some amount of astronomy was already known and practiced, as would be expected of a race which depended much on traversing the high seas and eking out an existence highly dependent on agriculture and the vagaries of the seasons. Juan de Plasencia, a Franciscan, thus recorded in his *Customs of the Tagalogs*, written in Manila in 1589:

> They worshiped, too, the moon, especially when it was new, at which time they held great rejoicings, adoring it and bidding it welcome. Some of them also adored the stars, although they did not know them by their names, as the Spaniards and other nations know the planets–with the exception of the morning star, which they called Tala. They knew, too, the "seven little goats" [the Pleiades–as we call them–and, consequently, the change of seasons, which they call Mapolon; and Balatic which is our Greater Bear. . . .[16]

The appearance of the Pleiades signified the beginning of the agricultural season, the fundamental unit through which early Filipinos organized their experience of change and of time. Miguel de Loarca in his 1582 account notes that it is when the Pleiades appear that a new agricultural cycle is deemed to start and preparations for the new planting season begin.

William Henry Scott, a specialist in early Philippine society, informs us that, apart from the Pleiades, other heavenly constellations were also used by ancient Filipinos to mark the changing seasons:

> The agricultural cycle began, as Loarca noted, with the appearance of certain stars. Most often these were the Pleiades in the constellation of Taurus which can first be seen in June locally called Moroporo, meaning either "the boiling lights" or a flock of birds. Swiddens were prepared at that time, and seeds were sown in September when they

> were directly overhead at sunset, though the exact time depended on local climatic conditions. Indeed, because the rainy season varied from island to island, in some places farmers made use of the Big Dipper (Ursa Major), which they called Losong (rice mortar) [from where the term Luzon comes] or Balatik (ballista), though in Panay Balatik was what they called the two bright stars in Gemini. Still others planted when the Southern Cross was upright at sunset, a constellation that looked to the Visayans it looked like [sic] a coconut palm, Lubi, or blowfish, Butete. Similarly, the constellation Aries, the Ram, they called Alimango, the Crab.[17]

This basic unit of change was given the name *taon* by the early Filipinos. The felicitously perceptive Franciscan Juan Francisco de San Antonio, already cited earlier, records for posterity the special meaning this term had in ancient times:

> They expressed "the year" in their old speech by the word *taòn*. It is metaphorical, for it really means "the assembling of many," and that they have joined together months to make one year. They had a word to signify seasons and climates, namely *panahòn*. But they never knew the word "time" [*tiempo*], in its general sense, and there is no proper Tagalog word for it; but they use the Spanish word only, corrupted after their manner, for they make it *tiyempo*.[18]

Taon, thus, did not exactly mean the year as the twelve calendar months corresponding to 365.25 days but referred to the larger phenomenon, encompassing cosmological, environmental, agricultural, and even religious elements, where and when everything got together—"the assembling of many"—to mark the start of a new season. The different uses of the term taon in present Tagalog and other Philippine languages give a glimpse of the original richness of the concept: *pagkakataon*, opportunity; *nagkataon*, by chance; *nataon*, to occur at the same time; *mataon*, to occur at the same time by chance; *itinaon*, to set or to schedule; *maitaon*, to be able to set or to schedule at the same time.

Scott reminds us that Visayans have three different words corresponding to "year"—*taon*, *tuig*, and *dag-on*, each having its special connotations. Scott, citing the Sanchez Visayan dictionary of 1617, says that *taon* means harvest, such as, "Taon na didto dile or It's already harvest in their place," and that old people were those who had seen many harvests (Sánchez 1617, 504v). *Tuig* also meant harvest, as in *tinutuigan* or what is ready for harvest, but it has the added connotation of anything periodic or recurring, such as the coming of the rains, *panuigan sang olan sang habagat* or *sang amihan*, either from the south or north, or the process of menstruation, as in *tinuig na siya*. The second meaning, it should be pointed out, demonstrates its affinity with the Tagalog *tuwing* which means every time or every occasion. *Dag-on* is when "everything is in bloom," such as the flowering of trees and plants, "*panog-on sa manga kakahuyan* or when everything is in bloom, indicating the alternation of the seasons."[19]

The Franciscan Plasencia unfortunately fails to appreciate the qualitatively different way ancient Filipinos conceived of change and of time, implicitly judging the ancient ways as inadequate practices which are fortunately going to be superceded with the continuing spread of Christianity:

> These natives had no established division of years, months, and days; these are determined by the cultivation of the soil, counted by the moons, and the different effect produced upon the trees when yielding flowers, fruits, and leaves: all this helps them in making up the year. . . .
>
> It seems, however, that now since they have become Christians, the seasons are not quite the same, for at Christmas it gets somewhat cooler. The years, since the advent of the Spaniards, have been determined by the latter, and the seasons have been given their proper names, and they have been divided into weeks.[20]

These changes Plasencia refers to involved not merely changing one name for another but more fundamental transformations involving worldviews as well as important semantic shifts in meaning. *Taon*, in due time, shifted meaning from its poetically-rich original connected with cosmic and agricultural cycles to the abstract, calendar-based meaning of 365.25 days, the present sense it has for modern Filipinos. Serrano Laktaw calls attention to this historical shift:

> Con la civilización que trajeron los españoles, conocieron el *taón* o año de 12 meses, adoptando los mismos nombres con que los nombran

los españoles los suyos, diciendo: *Enero*, *Febrero*, *Marzo*, *Abril*, *Mayo*, *Junio*, *Julio*, *Agosto*, *Setiembre*, *Octubre*, *Noviembre* y *Diciembre*.[21]

With the civilization brought by the Spaniards, they came to know the year of 12 months, adopting the same names used by the Spaniards, saying: January, February, March, April, May, June, July, August, September, October, November, and December.

But the original difference between the Filipino *taon* and the year or *año* was clear, as Alcina himself reminds us:

[Taon or tuig is a word] with which they also counted the years, but without computing or numbering the months, which from harvest to harvest they would count as eleven or twelve distinct and past, and which they called *tuig*, and although they now confuse it with the year, it was not a single year but an indefinite time because that word means to them the same as "time" does to us.[22]

In the same way the *taon* was conceived in terms of the periodic appearance of the Pleaides and other stars, the next unit used to organize time was the *buan*, literally the moon, where the taon was divided in terms of the different times the moon waxed and waned during the period. The month therefore in this ancient system was a lunar month, similar to Chinese practice, but quite different from the European calendar where calendar months do not coincide with the movements of the moon. Miguel de Loarca describes the practice:

They divide the year into twelve months, although only seven [sc. eight] of these have names; they are lunar months, because they are reckoned. The second is called Dagancahuy, the time when the trees are felled in order to sow the land. Another month they call Daganenan bulan; it by moons. The first month is that in which the Pleiades appear, which they call Ulalen comes when the wood of those trees is collected from the fields. Another is called Elquilin [Elkilin], and is the time when they bum over the fields. Another month they call Ynabuyan, which comes when the bonanças [or the fair winds when the monsoon is changing] blow. Another they call Cavay [Kaway]; it is when they weed their fields. Another they call [Cabuy: *crossed out in MS*.] Yrarapun; it is the time when they begin to harvest the rice. Another they call Manalulsul, in which the harvesting is completed. As for the remaining months, they pay little attention to them, because in those months there is no work in the fields.[23 24]

The moon, which waxed and waned more often than the corning and going of the stars, then acquired a magical meaning for early Filipinos, as Scott summarizes for us:

Visayans also believed that just as the moon times the human menstrual cycle, so its phases controlled all biological growth. Starfish were said to increase and decrease in size as the moon waxed and waned; crab shells hardened and softened to the same rhythm; yellow turtles only grew at nighttime when there was a moon, black ones during the dark of the moon, and white ones during the daytime. So too, coconut trees were thought to produce one new sprout each new moon; the silklike fibers of the *ulango* palm had to be gathered at quarter moon; and stems of boats made from *dao* roots could be expected to outlast the vessel but only if cut during the waning moon. Furthermore, Visayans had a prescription for which phase of the moon was best for gathering any of a dozen varieties of abaca, though the most commonly planted variety was one that could be cut at any time.

The dark of the moon was considered sinister because it was the favorite of witches and *aswang*, who fled at the first sight of the crescent moon showing its horns. Fieldwork and weaving were accordingly forbidden the following day as a precaution against illness during the coming month, and a one- to three-day holiday was taken to celebrate the full moon because the *diwata* came to earth at that time. Nobody doubted that an eclipse (*bakunawa*) was caused by a huge *sawa*, python, trying to swallow the moon, and that it had to be frightened away by noisy pounding on mortars and house floors, followed by another holiday. . . .[25 26]

The week did not correspond to any celestial cycle[27] so it did not form part of ancient Filipino system of reckoning time. There was no need to resort to the artifice of the week, since days within the *buan* or month could be precisely counted, as we shall soon see. But increasing Spanish inroads into Philippine culture assured that the concept of week would eventually be accepted. By the eighteenth century at least the concept of week was already in use, as recorded by San Antonio Francisco:

> [Days are counted] and so on until they have the difference of weeks, which they call by the name *Domingo*, saying "so many Domingos." [i.e., Sunday, Domingo being the Spanish word; evidence that this method of styling the week was evolved after the conquest].[28]

If the second basic unit of time was the *buan*, defined by the waxing and waning of the moon, then the system for measuring how far the current *buan* has elapsed was dependent on the moon's evolving shape in the night sky. The days or nights from one moon to a new one could be easily ascertained. Scott relates the detailed manner in which the progression of the month is monitored through a description of the moon's changing shape:

> The new moon was *subang* the first night it could be seen, or more colorfully, *kilat-kilat*, a little lightning flash. When it appeared as a full crescent the next night or two, it seemed to have opened its eyes (*gimata*) or, alternately, closed its mouth (*ungut*)—like a baby's on a mother's breast. Then came a "three-day moon" or high new moon, *hitaas na an subang*, followed by *balirig*, the fourth or fifth night, and next it was "near the zenith" (*odto*). When it appeared as an exact half disk—what western calendars call the first quarter moon—it was directly overhead at sunset, and therefore *odto na an bulan*. Then as it continued to wax, it "passed the barrier" (*lakad*), and when it was lopsided both before and after full moon, it looked like a crab shell (*maalimangona*).
>
> The full moon was greeted with a variety of names—*paghipono*, *takdul*, *ugsar*—but most significantly as *dayaw*, perfect or praiseworthy, fit recognition of its spectacular shape and sunset-to-sunrise brilliance. And as it began to wane—that is, darken (*madulumdulum*)—a night or two later, it set on the western horizon just before dawn and so was called *banolor*, to exchange or take by mistake—like a man who dies just before a son or grandson is born. The fifth or sixth night of waning was *parik*, to level or flatten, because it then rose so late the witches had many hours of darkness in which to beat down the earth by the stomping of their feet during their dances. *Katin* was the third quarter, so it had crossed this second barrier (*lakad na an magsaguli*) by the twenty-fourth or twenty-fifth night, and then got ready for new moon again (*malasumbang*) about the twenty-ninth. This was the dark of the moon, or what the Spaniards called *conjunción* (meaning the conjunction of the sun and the moon) when the moon disappeared for a night or two. To the Visayans, it was then dead, lost, or gone hunting.
>
> These phases of the moon were common time markers known to all. They would say, for example, "Duldulman an bulan [The moon begins to wane today]" or "Paodtononta an bulan [Let's wait for the quarter moon]" (Sánchez 1617, 37, 188). And *nasubang nga tao* was a newcomer or upstart.[29]

The Tagalogs, however, had a slightly different method, preferring to count days rather than the Visayan practice of marking nights. As San Antonio records:

> The days were reckoned by the name of the sun, namely, *árao*. Thus the Tagalogs now reckon *ysang árao* "one day;" *dalauang árao*, "two [days]."[30]

The next units of organizing time based on natural periodic occurences in nature were, alternatively, day and night. "The night is called gab-i; and the day arao, from the name of the sun."[31]

It cannot be ascertained for the moment when the European clock was introduced to the Philippines. But the *Cronicas* of San Antonio records the use of the clock and the acceptance of the concept of the hour by the eighteenth century:

> Only there are no terms to indicate the hours of the clock [in their speech]; and now the Castilian [names of] hours are Tagalized, in order to indicate the hours of time. They call the clock *horasàn*, that

is, "a thing in which one sees the hours;" whether in its place or in the instrument made for it.[32]

Prior to the use of the concept of hour to subdivide the day, ancient Filipinos determined the time of day through the movement and position of the sun, with both the Visayans and Tagalogs using picturesque descriptions of the passing of time during the day.

Scott summarizes the manner in which Visayans marked time during the day:

The Visayans divided the daylight hours into a dozen or more specific times according to the position of the sun. Between dawn and noon, they reckoned *nasirakna*, shining, and *nabahadna*, climbing, and then *iguritlogna*, time for hens to lay, and *makalululu*, when your bracelets slid down your raised arm if you pointed at the sun. High noon was *odto na an adlaw*; followed by two points of descent in the afternoon, *palisna* and *ligasna*; until midway to setting, *tungana*. *Natupongna sa lubi* was when the sun sank to the height of the palm trees seen against the horizon; and sunset was *apuna*; or *natorma*, when the sun finally disappeared. Day ended with *igsirinto*, when it was too dark to recognize other people.[33]

The Tagalogs, on the other hand, had their own system and terminology, summarized for us by Serrano Laktaw.

The day was divided in the following manner:

Los momentos del día las distribuían así: *pagsíkat nanğ tálang baquero*, como las tres y media de la mañana; *pagsíkat nanğ tálanğ batúgan*, al salir del lucero; *maralinğ áraw*, el amanecer; *pagliwayway*, *kunğ bukanğliwayway*, al romper el alba; *pagbabâ nang manok*, al bajar los gallos, estando ya bastante claro, pero aún sin sol; *namímitak na anğ áraw kunğ umááraw na*, la salida del sol; *áraw na kunğ umaga na*, ya es de día; *hampás tikín anğ áraw*, como las siete de la mañana, que es cuando dicen estar el sol al alance de un tikin; *maaga pa*, aún es temprano, como las siete y media o las ocho de la mañana; *mataás na anğ áraw*, ya está alto el sol, como a las diez hasta las doce; *tanhali*, *katanhalíän*, mediodía; *tanháling tapat*, *tanhálinğ tírik*, *saulo anğ áraw*, a medio día en punto, porque habiendo llegado el sol al cenit proyecta su luz directamente sobre la cabeza; *likid na*, kunğ *kiling nğ*, a las doce y media o la una; *lipás na*, a las dos; *mababá na*, cuando el sol va cayendo, como a las cuatro; *lúlúnod na*, cuando está para ponerse el sol; *nalúnod na*, ya se puso el sol.[34]

The moments of the day are divided in the following manner pagsikat nanğ tálang baquero, around 3:30 in the morning; pagsikat nang tálangbatúgan, when the light comes out; madaling a'raw, the dawn; pagliwayway, kung bukangliwayway, when dawn breaks; pagbabanang manok, when the cocks come down, already a clear sky but still without the sun; namimitak na anğ áraw kung umááraw na the appearance of the sun; áraw na kung umaga na, it is already day; hampás tikin anğ áraw, around seven in the morning, when they say that the sun is within the grasp of one un tikin: máaga pa, it is still early, around seven thirty or eight in the morning; mataas na ang araw, the sun is already night, around ten until twelve; tanhali, katanhalián, midday; tanháling tapat, tanhaling tirik, saulo anğ áraw, high–noon, because the sun, having reached its height, now projects the light directly above the head; likid na, kung kilinğ na, twelve–thirty or one; lipás na, two o'clock; mababa na, when the sun starts to go down, around four o'clock; lulunod na, when the sun starts to disappear; when the sun already has set.

The night, on the other hand, had less divisions:

A la noche llaman *gabí*. Y sus momentos las reparten así: *silim na* kunğ *sumísilim na*, va oscureciendo; *takipsilim*, entre dos luces; *malálim na anğ gabí*, muy avanzada la noche como a las diez o las once; *hátinğgabí*, media noche.[35]

The night is called *gabí*. And it is divided in the following manner: *silim na kunğ sumísilim na*, when it is getting dark; *takipsilim*, between two lights; *malálim na anğ gabí*, when the night is already very advanced, like ten or eleven in the evening; *hátinğgabi*, midnight.

Serrano Laktaw notes that with the spread of the watch this system disappeared, eventually replaced by the European method of telling time: "Con la vulgarización del reloj va desapareciendo todo esto, y se cuenta ya al estilo europeo" (With the spread of the watch all of this started to disappear, and now they count time in the European style).

The Scales and the Confessional

Commerce within the islands as well as trade with its Southeast Asian neighbors required the development of a system of weights and other measures.

It was almost natural that the system of dry measures would revolve principally around the staple food, rice, but the system was also used to measure salt, mongo, and others.

The most common measure would have been the *dakot* or handful since this would have been the most convenient way to handle the grain. But quantities in this system would of course have varied from hand to hand so a more uniform system had to be evolved for trade. Serrano Laktaw records the old system of the measurement of volume that evolved in the trading of these commodities:

MEASURE	DEFINITION	METRIC EQUIVALENT
Kabán	25 *gantas* or *salop*	75 liters
Kalahatian	half a cavan	37.5 liters
Ganta or **salop**	8 chupas	3 liters
Kágitnáan (or kalahating salop or kalahating ganta)	4 chupas	1.5 liters
Chupa, gátañg or gahenan	4 apatan	0.375 liters
Apatan		

The three more important measures are printed in bold. Serrano Laktaw leaves *apatan* undefined and without a metric equivalent in his *Estudios gramaticales*. While the previous definitions provide us with enough information to calculate the metric equivalent of *apatan* to be 0.09375 liters, this arithmetical exercise appears to have little mathematical and practical sense since this measure was never meant to be used with this digital exactness. The better approach to appreciating this ancient method of measuring the volume of grains and similar items is to view the *kabán* as the measure used for wholesale or bulk transactions, while *ganta*, *salop*, and *chupa* were used for retail purposes. These senses of the terms are still partly preserved in present-day Tagalog where *kabán-kabán* is used to denote, sometimes even in figurative speech, great quantities or bulk deliveries, while one can still hear, at least in the mind's ear, a mother's instructions to buy *kalahating salop ng bigas* or half a *salop* of rice from the neighborhood store when the household readies itself for lunch, a practice observed at least up until relatively recent times before the metric system completely totally took over.

The *ganta*, *salop*, and *chupa* were defined in terms of each other through multiples of eight and four, most probably because the way they were measured and compared with each other was through a continuous division by two, since dividing by halving was the most convenient and comparatively more accurate way of dividing a quantity of grain.

It might appear at first that the system is inconvenient since the *kabán* was defined as a multiple of 25 of the *ganta* or *salop*, making direct comparisons with the *chupa* and *apatan*, which were related to the *ganta* or *salop* by multiples of two, difficult. But reflection tells us that this would have not been much of a practical problem if we accept the observation made earlier that the *kabán* was a wholesale unit, while the rest were for retail transactions, thus making direct calculations between the *chupa* and the *kabán* for example, unnecessary.

Serrano Laktaw instructs how counting using these measures was conducted:

> Y la fraseología era: *isanğ gátanğ na bigás* o *isanğ gahénanğ bigás*, una chupa de arroz limpio hasta 7 solamente, porque 8 chupas ya forman *sanğsalop*, una ganta, hasta 24 salop o ganta, porque 25 de estos forman ya *sangkabán*, un caván. Desde aquí con *labí sa* hasta dos cavanes, *dalawang kabán*; *labí sa* kabán sanğsalop, un caván y una ganta, etc.[36]
>
> The phrasing was *isanğ gátanğ na bigás* or *isanğ gahénanğ bigás*, one chupa of clean rice until 7 only, because 8 chupas already form

sanğsalop, one ganta, until 24 salop or ganta, because 25 of these already form *sangkabán*, one cavan. From here with *labí sa* until two cavans, *dalawanğ kabán*; *labí sa* kabán sangsalop, one cavan and one ganta, etc.

The verb *takal* signified the act of measuring, usually through the *salop* or *ganta*, the traditional metering container, while the progressive form of the verb, *tinatakal*, connotes either the act of measuring or the act of slowly transferring from one container to the other. The word is explained in the *Cronicas* of Fray San Antonio: "The act of measuring in this manner is expressed by the word 'tacal' among the Tagalogs."[37]

This ancient method of measurement lasted, surprisingly, until very late in Philippine history, when in the 1970s the use of the metric system was dictated by presidential decree. Prior to that, rice retailers had to register their wooden measuring boxes with the proper government offices to ensure that they complied with the standard volume for the *ganta*, *salop*, and *chupa*, with the wooden boxes duly stamped to ensure proper compliance and ensure that the public was not defrauded by unscrupulous merchants. But even when the proper scales were used, some amount of fraud was still possible, as when an experienced hand could vary the amount of rice by pouring it only very lightly into the measuring box, equally careful in shaving the top of the box with the traditional ruler-like wooden stick, resulting in less rice filling the purportedly standard measuring box.

These unscrupulous practices, which the introduction of the metric system in the 1970s attempted to remedy through the measurement of metric weight rather than traditional volume, were, amusingly, apparently already practiced in early Philippine society, as gleamed through Fray Sebastian de Totanes's 1745 *Manual tagalog para la administracion de los sacramentos.*[38] *Manual tagalog*, published together with Totanes's *Arte de la lengua tagala*, was a manual to help Spanish priests, especially those who were still struggling to learn Tagalog, to administer the sacrament of confession, by providing a set of ready questions for the penitent. The questions, quite detailed and even overly suggestive, were divided into two, depending on whether the father confessor wanted to administer a regular, lengthy confession or a shorter one. The regular confession, or *La buena confesión*, comprised 429 questions, at least in our count, covering items number 124 through number 553, from pages 56 through 143, while the shortened version, or *Confesionario breve*, had 82 questions, found on pages 143 through 154 of the *Manual tagalog*, with both sets consisting of quite detailed, truly embarrassing personal questions of the penitent. The questions were organized around the different commandments the penitent might have transgressed.

For our present purposes, Question # 456 of Totanes's *Manual tagalog*, based on the seventh and tenth commandments, provides extremely amusing historical color to our discussion of ancient Filipino weights and measures. Totanes first states the seventh and tenth commandments in Old Tagalog and in Spanish:

Ang icapito, at icapolong otos nang P. Dios
Houag cang magnacao.
Houag cang magnasa nang di mo ari.

El séptimo, y décimo mandamientos de Dios Ntro. Señor
No hurtes.
No desees la hacienda agena.[39]

Then forming part of the examination of conscience of the penitent for these commandments is the following question:

456. Has usado de dos gantas, ó medidas una grande para comprar, y otra pequeña para vender á otro? Y lo mismo te pregunto en cuanto á pesar, y medir con vara, braza, etc.

456. Nagdalaua cang salop caya sa pagtacal; isang malaqui sa pagbili mo, at isang munti sa pagbibilimo sa iba? At gayon ding itinatanong co sa iyo tongcol sa pagtitimbang, at sa pagsucat nang balanga?[40]

456. Have you used two measures, either in gantas or salop, a big one for buying and another, a smaller one, for selling to others? I also ask the same concerning weighing and measuring. . . etc.

The question is doubly amusing, since it shows that the practice of merchants defrauding their clients through a false system of weights and measures was already in practice as early as the time of Totanes, and also since the question, no matter how innocent the intention was in asking, was actually opening the possibility of the crime to the penitent who might otherwise not have thought up the deed.

But if there was any fiddling around with the system of measuring volume, the most grievous would not have been the occasional, petty peccadillo of mischievous individuals. Fray San Antonio hints at how the Spanish crown defined and employed the weights and measures used so that the friars could maximize what they received:

> When the king issues orders for rice, it is reckoned by cabáns of twenty-four gantas apiece; and now it is known that it is of pálay rice, which is rice with the husk and uncleaned. When vouchers are issued for the stipends and the support of the religious ministers, the reckoning is by fanegas, at the rate of two cabáns of twenty-four gantas each, of the said pálay rice uncleaned. And because his Majesty chooses that they give it to us very clean, it is now ruled in the royal accountancy that forty-eight gantas of the fanega of pálay is equivalent to a basket of twenty gantas of bigas, which is the name for cleaned rice. Hence the king in his charity, in order to give us our sustenance in the rice without waste, gives valuation to the measure at his own pleasure, for the rice with husk, so that the quantity may be doubled. The estimation of the king in this is not the same as looking into the hollow measure in its strict capacity, as has been already explained.[41]

The *salop* or *ganta*, it appears, was extended to also serve as a system of measuring liquids such as wine, vinegar, and oils, all products from thriving industries. The accepted unit was the *tinaja*, equivalent to 16 *gantas*, while the smallest was the *bukohan*, *súbok salop*, or *salopan*, all equal to one *ganta*, the first expression related to the quantity which might fit within a coconut shell, hence the term *bukohan*, while the last clearly relates to *salop*, which explains the consequent identification of meanings between the terms *ganta* and *salop* in the system of dry measures. Serrano Laktaw lists the other measuring cups which were known to have existed:

NUMBER OF SALOP AND GANTAS	
Animan	six
Pitohan	seven
Walohan	eight
Labíngisá o labingisahan	eleven
Dalawanĝpuoán	twenty

The measurement of weights, on the other hand, took two forms, using two different types of scales, depending upon the quantity to be measured and the accuracy required.

Items of high value, which needed accurate measurement, were weighed through the *talaró* or *timbangan*, the latter term still the popular name for the weighing scale. This is the usual balance with two weighing plates on each side, with some designed to be small enough to be carried in person.

> Those metals were employed in their trading only by the weight, which was used alone for silver and gold; and that weight they called *talàro*, and was indicated by balances, like ours. They reckoned and divided by this.[42]

The unit used for gold and other items where precise measurements were especially desired was called *tahel*, with the *tinga*, *sapaha*, and *ama* forming the other units for progressively lower quantities.

> The gold, which they call *guinto*, was also reckoned by weight. The largest weight is the *tahel*, which is the weight of ten reals of silver—or, as we say, of one *escudo*. The half-tahel is called *tinga*, which is the weight of five reals. The fourth part is called *sapaha*, which is two and one-half reals.[43]

Serrano Laktaw and Scott provide us this table of weights:[44]

1 táhel	2 tinĝa [or paningan]
1 tinĝá	2 sapahà
1 sapahà	2 amas
1 amas	2 balabato
1 balabato	2 kupang
1 kupang	

This means that, for example, four *kupang* was equivalent to one *mas*, while one *tahel* was equal to 16 *mas*. Alternative spellings and pronunciations for *tahel* are *tahil*, *tael* or *tae*; *amas* was also *mas*, from the Malay *emas*.

An alternative manner of weighing small quantities, perhaps yet more ancient than the foregoing, is to compare the gold with beans or rice:

> They also used other metaphorical terms (as the Spanish do the term granos), and said sangsága, which is the weight of one red kidney-bean [frixolillo] with a white spot in the middle.[45]

This little seed was called *saga* or *sangsága* and served as the basic unit of weight in this system. Gold and gold dust, used as a means of payment, therefore were measured as multiples of these beans, with the following other units used:[46]

1 balay	3 bahay
1 bahay	3 saga
1 saga	

Tagalogs treated one *saga* as the equivalent of three *palay* (grain of rice) seeds. Scott therefore observes that the term *sumasaga* was extended to mean buying cheap items.

Such precise measurements then required accurate scales. Scales which gave the fair and exact weight were called *matapat na taiarô* while the untrusty ones were referred to as *may kaná*.

The measurement of heavier items required the use of another type of weighing scale, called the *sinantanan* or *sinantan*, what the Spaniards term the *romana*, where there is only one weighing plate and the balance is achieved through a system of weights on the lever, such as the system used in the infirmary scales to measure the weights of patients before digital and spring systems were adopted:

> In order to weigh bulkier things, such as wax, silk, meat, etc., they had steelyards, which they called *sinantan*, which was equivalent to ten cates, of twenty onzas [i.e., ounce] apiece. The half of that they called *banál*, which was five cates; and the half of the cate they called *soco*.[47]

Serrano gives the two tables for the system of weights, the second providing the Spanish equivalents used during the early period of colonization:[48]

UNIT	EQUIVALENT
1 pico	10 sinantan
1 sinantan	2 banal or 10 kate
1 banal*	5 kate
1 cate	2 soco or 16 tahel
1 soco*	8 táhel
1 táhel	16 amas o adarmes

SPANISH UNIT	
1 quintal	4 arrobas
1 arroba	25 libras
1 libra	16 onzas
1 onza	16 adarmes

There appears to have been an attempt to place a uniform system of weights during the early eighteenth century. San Antonio, writing in his *Cronicas*, records this attempt and the resulting equivalents:

> Consequently, these old weights having been adjusted to the Spanish weights by the regulations of the year 1727, one cate is equivalent to one libra, six onzas; one chinanta to thirteen libras, and twelve onzas; hence one quintal, of eighty of the old cates, corresponds to four arrobas and ten libras of our weight. A *pico* of one hundred cates is equivalent to five arrobas, twelve and one-half libras, in the new arrangement. As in the case of gold, one tahel must weigh one and one-fourth onzas in our weight.[49]

Very little of these ancient practices survive. Since the Spanish colonial administration continually used the European system in their measurements, the traditional, even poetic, methods of counting had to give way to the metric system. Serrano Laktaw thus laments:

La adopción del sistema métrico–decimal abolió poco a poco estas nativas antigüedades, hasta el punto de que en la actualidad ni noticia de ellas tiene la presente generación.[50]

The adoption of the metric–decimal system little by little abolished these native ancient practices, until we have reach the point that the present generation does not even have news of them.

Counting and the Last Number

We discuss in this section the counting system and the different kinds of numbers ancient Filipinos used.[51]

Cardinal numbers in Old Tagalog can be classified into either simple or complex. Simple numbers are those which consist of one single meaningful element, while complex numbers are those which are made up of more than one meaningful element.[52]

Simple cardinal numbers in Old Tagalog are the counting numbers from one through ten:

1–10

*Isá	1
*Dalawá, o dalwá	2
*Tatló	3
*Ápat	4
*Limá	5
*Ánim	6
*Pitó	7
*Waló	8
*Siyam	9
*Puló or Puô	10

The old system of counting in Tagalog made a distinction between *puló* and *puô*, both of which signified ten. *Puló* was used when counting consecutively, as from one through ten.[53] *Isa*, *dalawa*, . . . *puló*. The origin may have come from *punô*, meaning full, indicating that the fingers of the two hands were already full in the counting process. *Puô*, on the other hand, was a contraction from *puló* and was used when the quantity ten was used by itself, adding the prefix *isang* or *sang*, producing *sangpuô*. Modern usage merely uses the latter, *sangpuô*, usually further contracting the word from *sangpuô* to *sampu*.

Complex numbers in Tagalog are formed by using one of the simple cardinal numbers and combining it with another meaningful element.

The numbers 11 through 19 are formed in this way:

11–19

*Labi-ng-isá	1 more than 10	11
*Labi-ng-dalawá	2 more than 10	12
*Labi-ng-tatló	3 more than 10	13
*Labi-ng-ápat	4 more than 10	14
*Labi-ng-limá	5 more than 10	15
*Labi-ng-ánim	6 more than 10	16
*Labi-ng-pitó	7 more than 10	17
*Labi-ng-waló	8 more than 10	18
*Labi-ng-siyam	9 more than 10	19

Numbers 11 through 19 are formed by adding the prefix *labing* to the simple root number. The prefix is formed from *labi* or more than plus the linker –ng. *Labingtatlo* or 13, for example, means three more than 10.[54] This method implies the use of Base 10. This system also implies the process of addition and the mathematical notion of greater than (>). In contrast, European languages, English included, generally use the equivalent of the conjunction "and" to form the number—for example, 22 would be generally expressed as twenty and two.

Multiples of 10

*Dalawanĝpuô	20
*Tatlonĝpuô	30
*Apat na puô	40
*Limanĝpuô	50
*Anim na puô	60
*Pitonĝpuô	70
*Walonĝpuô	80
*Siyam na puô	90

The number 20 is expressed as a multiple of 10, as are all multiples of 10, until 90. *Dalawangpuô*, *tatlongpuô*, . . . *siyam na puô*. Linguists who have studied the language used to express the multiples of ten believe that there is an implied process of multiplication involved: "pu times ten."[55] Thus, *dalawangpuô* is really *dalawa na puô*—or two times 10; *tatlongpuô* is *tatlong na puô*—or three times 10.

The interesting implication here is that for double digit numbers, with the exception of multiples of 10, the implied operation of addition is involved—or more precisely, the relation greater than (>)—where the number in the one's place is added to the number in the tens place or compared as a relation. But when it comes to the multiples of ten, the implied process is multiplication, where a number is multiplied by *puô* or 10.

21–100

The conceptual framework and the corresponding grammatical rules undergo a significant change starting with the number 21 in Old Tagalog.

Twenty-one is expressed in old Tagalog as *maykatlongisa*.

Numbers from 21 through 99, with the exception of the multiples of ten which follow their own rules, are formed by combining four semantic elements:

- the prefix *may*– or *mey*–;
- the second prefix or infix –*ika*– or –*ka*–;
- the multiple of ten towards which one is counting;
- the number in the one's place.

The rule for forming numbers starting with 21 is to use the prefix *may*–, signifying to have or to have in existence, then add the infix –*ka*–, a contraction of –*ika*–, then use the multiple of 10 towards one is heading, such as 30 when one is expressing 21, then the actual quantity in the one's place, in this case *isa* or one. Thus 21 is expressed as *may–ika–katlong–isá* or simply *maykatlongisa*.

Serrano Laktaw gives us this example from the counting of *kabans*:

> De *dalawanğ kaban*, en adelante, con *may*, como queda dicho en los cardinales: *Mayka*tlonğ kalaháting̃ kabán, dos cavanes y medio.[56]
>
> From two kabans onwards, with –may–, just in the same way as in the cardinal numbers: Maykatlonğ kalaháting̃ kaban, two kabans and a half.

We have two authorities from the early eighteenth century who explain to us the use and the conceptual significance of this method of counting.

Gaspar de San Agustin, writing in his 1703 *Compendio del arte de la lengua tagala*, explains that writing 21 as *maykatlongisá* is really in effect saying the quantity one towards the number 30: "—*May catlong isa*—, veinte y uno, esto es uno para treinta, etc."[57]

Fray Sebastian de Totanes, whose *Confesionario* we already cited earlier, has basically the same explanation, when he says that we are really indicating the multiple of ten towards which we are walking or heading, and that this is the manner of counting until we reach 100:

> Para proseguir contando desde 20, se hace con –*mey*–, que significa tener, tomando el numero del diez á que se camina (que desde 20. Vg.: es –*tatlo*–, porque es el 30, ó tercer diez) anteponiendoles –*ca*–, y despues el número intermedio ligado con el mismo diez, con sola –*n*–, si este acabase en vocal, ó sin ligazon alguna, si acaba en consonante; y asi se prosigue hasta 100 que es –*daan*–, pero para nombrarle solo, se le antepone –*sang*– (segun el citado no. 359) Y dirá en rigor tagalog, tengo para 30. Vg.: Tantos que en nuestro castellano son veinte y tantos, Vg.[58]
>
> To continue counting from 20, one does it with –*mey*–, which signifies "to have," taking the multiple of ten towards one is heading (which from 20 is three, because it is 30, or the third ten), placing before it –*ca*–, and then a single –*n*– after the intermediate number connected with the same ten, if this number ends with the vowel 'o', without any addition if it ends with a consonant. In this way one heads towards 100, which is –*daan*–, but to name it by itself, one places –*sang*–. And in Tagalog one will say, "I have so much towards 30, which in our Spanish is twenty and something."

Here are the examples from Serrano Laktaw:

20–100

Maykatlonğisá	21
Maykatlonğdalawá	22
Maykatlonğtatló	23
Maykápat na isa	31
Maykápat na dalawá	32
Maykápat na tatló	33
Maykalimanğisá	41
Maykalimanğdalawá	42
Maykalimanğápat	44
Maykánim na isá	51
Maykánim na tatló	53
Maykánim na limá	55
Maykapitonğisá	61
Maykapitonánim	66
Maykapitonğpitó	67
Maykawalonğisá	71
Maykawalonğtatló	73
Maykawalonğápat	74
Maykasiyam na isá	81
Maykasiyam na pitó	87
Maykasiyam na waló	88
Maykaraanğisá	91
Maykaraanğápat	94
Maykaraanğsiyam	99

Later Tagalog counts these numbers differently. In contrast to the ancient method, it now merely uses the coordinating conjunction "at" to imply the addition of the number in the one's place to the number in the ten's place, much in the same way that Western systems do, a clear indication of the later Spanish influence on the numeration system. Thus, 21 is no longer *maykatlongisá* but *dalawangpu at isa* or *dalawampút isa*, losing the implicit image of counting or heading towards a fixed amount in favor of the implied process of addition. This is now how the modern Tagalog speaker would say the number.

> Más tarde se adoptó la manera de contar española: isanğ kabán at kalahati, caván y medio; sanğdaanğ kabán, ápat na salop at limanğ gátanğ o gahenan, cien cavanes, cuatro gantas y cinco chupas, etc.[59]

> Much later, the Spanish system of counting was adopted: isanğ kabán at kalahati, one and a half cacán sanğdaanğ kaban, ápat na salop at limanğ gatanğ o gahenan, one hundred cavanes, four gantas and five chupas, etc.

100–199

The formation of numbers from 101 through 199 in the ancient system was formed in a way similar to the formation of numbers below 100, where they were designated by simply using the prefix *labi–sa*. This time the prefix *labi–sa* is placed before the term *daan*, while the quantity over a hundred, occupying the one's and the ten's place, is placed after it. Thus, in the old system, then number 101 is *labi sa raan isa*. (The modem method again follows the Spanish where the conjuction "at" or "and" is used—for example, *isangdaan at dalawangpuo* for 120, which in the ancient method would be *labi sa raan dalawangpu*.) The set of numbers 101 through 199 analogously follows the rules for forming numbers 11 through 19, implying the relation of more than or greater than (>).

Here are Serrano Laktaw's examples:

Labi sa raan isa	101
Labi sa raan sanğpuô	110

Labi sa raan labing̃ isá	111
Labi sa raan tatlong̃puô	130
Labi sa raan maykápat na isa	131
Labi sa raan apat na puô	140
Labi sa raan maykalimang̃dalawá	142
Labi sa raan limang̃puô	150
Labi sa raan maykánim na ápat	154
Labi sa raan ánim na puô	160
Labi sa raan maykapitong̃limá	165
Labi sa raan pitong̃puô	170
Labi sa raan maykawalong̃ánim	176
Labi sa raan walong̃puô	180
Labi sa raan maykasiyam na pitó	187
Labi sa raan maykaraang̃tatló	193

Multiples of 100 are formed in a fashion analogous to the formation of the earlier multiples of 10. An implied process of multiplication is involved in counting by the hundreds, where *daan* signifies "times one hundred" or multiplication by 100. Thus, *isangdaan* or *sangdaan* (100) is one multiplied by a hundred; *dalawangdaan* (200) is two multiplied by a hundred; and so on.

Multiples of 100

*Sang̃daan	100
*Dalawang̃daan	200
*Tatlong̃daan	300
*Ápat na raan	400
*Limang̃daan	500
*Ánim na raan	600
*Pitong̃daan	700
*Walong̃daan	800
*Siyam na raan	900

201–999

Counting from 201 through 999 is done with the prefix *may–*, in a manner analogous to counting from 21 through 99:

Maykatlong̃daang̃isá	201
Maykatlong̃daang̃ sangpuó	210
Maykatlong̃daang̃labingisá	211
Maykatlong̃daang̃dalawang̃puô	220
Maykatlong̃daang̃ maykatlong̃isá	221
Maykatlong̃daan maykápat ná dalawá	232
Maykápat na raang̃tatló	303
Maykápat na raang̃ maykalimang̃tatló	343
Maykalimang̃daang̃ dalawá	402
Maykalimang̃daang̃ maykápat na ápat	434
Maykalimang̃daang̃ maykápat na waló	438
Maykánim na raang̃ápat	504
Maykánim na raang̃ maykánim na limá	555
Maykánim na raang̃ maykapitong̃ápat	564
Maykapitong̃daang̃ isá	601
Maykapitong̃daang̃ maykalimang̃ limá	645
Maykapitong̃daang̃ maykapitong̃ pitó	667
Maykawalong̃daang̃labing̃tatló	713
Maykawalong̃daang̃maykatlong̃limá	725
Maykawalong̃daang̃maykawalong̃pitó	777
Maykasiyam na raang̃pitó	807
Maykasiyam na raang̃maykápat na limá	835
Maykasiyam na raang̃ maykasiyam na waló	888
Maykalíbong̃waló	908
Maykalíbong̃ siyam na puô	990
Maykalíbong̃ maykaraang̃ siyam	999

1000

*Sanĝlibo	1,000

Isang libo is 1,000, or one times one thousand, again *libo* signifies multiplication by a thousand, analogous to the multiples of ten and hundred.

From 1,001 through 1,999, the prefix *labi sa* is used, exactly in the same way that numbers were formed from 101 through 199: *Labí sa libo isa*: 1,001.

2001

From 2,001 through 9,999, the prefix *mayka–* is used, exactly in the same manner that numbers were formed from 201 through 999, as for example: *Maykatlonglibonĝ–isá*: 2,001.

Maykatlonglibonĝtatló	
Maykatlonglibotatlonĝdaan	2,300
(for greater clarity, the second form for 2,300 is used)	

Maykasiyam na líbomaykawalongdaanglimá	8,705
Maykalibonĝlibomaykasiyam na raanĝápat	9,804
Maykalibonĝlibomaykasiyam na raanĝlabinĝwaló	9,818

10,000

*Sanglaksa	10,000

Ten thousand was termed *isang laksa*. Again, as in the previous multiples of 10, a process of multiplication, this time by 10,000, was implied by the use of the term *laksa*, such that *dalawang laksa* or 20,000 was two multiplied by 10,000.

The term comes from the Sanskrit *–laksha–* which means 100,000, but the meaning changed into the lesser quantity of 10,000 as it passed on to Old Malay and Old Tagalog.[60] The term still exists in ordinary Tagalog, albeit with phonetic changes, as *dagsa*, signifying a great amount, as in *dagsa-dagsa* or *nagdagsaan ang mga tao sa* EDSA—an uncountable or great number of people went to EDSA.

From 10,001 through 19,999, the numbers are formed in the same way as they were formed from 1,001 through 1,999:

Labi sa laksâ ápat na puô	10,040
Labi sa laksâ ánim na puô	10,060
Dalawanĝlaksâ	20,000

From 20,001 through 99,999, they are formed with the prefix *mayka–* in the same manner as 2,001 through 9,999:

Maykatlonĝlaksanĝ maykalíbonĝlibo	29,000
Maykatlonĝlaksanĝ maykalíbonĝlibo maykawalonĝdaan~may kawalongwaló	29,778
Maykalimanĝlaksanĝmaykatlonĝlibonĝ maykasiyam na raan maykápat na dalawa	42,832

100,000

*Sanĝyuta	100,000

A hundred thousand or 100,000 was termed as *yuta*, *yota*, or *sangyuta*. The use of *yuta* again implied, as in the previous multiples of 10, the process of multiplication, such that *dalawang yuta* meant two times 100,000 or 200,000.

Pardo de Tavera writes that *ayuta* originally meant 10,000 in Sanskrit, implying that there has been a semantic interchange of meaning between *yuta* and *laksa* as it passed into Old Tagalog.[61]

100,001–199,999

The formation of numbers from 100,001 through 199,999 is through the previous artifice of the prefix *labi sa*, exactly in the same way as one counts from 10,000 through 19,999:

Labí sa yutà sanĝpuó	100,010
Labí sa yutà maykatlonĝdaan labinĝsiyam	100,219
Labí sa yutà maykawalonĝdaanĝ maykapitonĝ limá	100,765

200,001–999,999

From 200,001 through 999,999, the numbers are formed with the prefix *mayka–*, in the same way that they were formed when counting from 20,001 through 99,999:

Maykatlonĝyutà tatlonĝpuô	200,030
Maykápat na yutà maykanim na pitó	300,057
Maykawalonĝyutà labí sa laksâ maykatlonĝlibo maykapitonĝdaan maykawalonĝánim	712,676

1,000,000

*Sanĝanĝawánĝaw	1,000,000

One million is *sang–angaw–angaw* or one times 1,000,000, in the same way that the previous multiples of 10 denoted multiplication.

It can also be expressed in the following alternative ways:

Angawangaw Isangangawangaw sanĝanĝawánĝaw (or sanĝpuonĝyutà)	1,000,000

Expressing one million as *sangpuongyuta* or ten 100,000, implies, as in the previous cases, a clear understanding of place value.

10,000,000

Ten million in Old Tagalog is *–cati–*or *–kati–*.

Pardo de Tavera gives us enough information to construct the following table to track the changes in meaning as the words passed from Sanskrit to Old Malay, to Old Tagalog:[62]

	YUTA	LAKSA	KATI
Sanskrit	10,000 (ayuta)	100,000 (laksha)	10,000,000 (kôti)
Old Malay	1,000,000 (yuta, djuta)	10,000 (laksa)	100,000 (keti)
Old Tagalog	100,000	10,000	10,000,000

With regard to the number *–cati–* or *–kati–*, or 10,000,000, Pardo de Tavera observes that it is perhaps the only word for a number which has preserved its original Sanskrit meaning as it passed into Old Tagalog: "Este es quizás al único ejemplo de un nombre de cantidad que conserva, al pasar al Tag., la misma significación que en el Sans" (This is perhaps the only example of the name of a number which preserved, upon its passing into Tagalog, the same meaning it had in Sanskrit).[63]

It should be clear that this system of counting was an extremely sophisticated one. Spanish friars who studied Tagalog grammar expressed great amazement at the consistency and efficiency with which the language formed words to express numbers. Fray Sebastian de Totanes records these observations:

> Este es el rigoroso modo de contar el tagalog. Para comprender bien el ingenioso artificio, con que cuentan, nótese en lo dicho lo uniforme, que procede en todas sus mutaciones. Desde el primer 10, hasta el segundo (que es el 20,) cuenta con *labi*; pues lo mismo observa desde el primer 100, hasta el segundo (que es el 200,) y desde el primer diez mil, hasta el segundo (que es el veinte mil,) y desde el primer cien mil, hasta el segundo, que es el doscientos mil. Desde el segundo diez, (que es el veinte) hasta el décimo diez, (que es el ciento,) cuenta con *mey*; pues lo mismo hace desde el segundo ciento, (que es el doscientos), hasta el décimo ciento, (que es el mil,) y desde el segundo diez mil, (que es el veinte mil,) hasta el décimo diez mil, (que es el cien mil,) y desde el segundo cien mil, (que es el doscientos mil,) hasta el décimo cien mil, que es el millon. Todo se verá practicado en lo dicho, si se reflexiona para comprender el artificio. Aunque ya con la comunicacion de los españoles, muchos cuentan como nosotros, y asi dicen: *Dalawangpuo at isá*, veinte y uno. *Sangdáan at limá*, ciento y cinco. *Limánĝ daang dalauánĝpouó at limá* quinientos y veinte y cinco, y asi de los demás números.[64]

> This therefore is the rigorous method through which the Tagalog counts. In order to understand well the ingenious artifice through which they count, note how uniform it proceeds throughout all of its changes. From the first 10 until the second (which is the number 20), it counts with *labi*; well, the same is seen from the first 100 until the second (which is 200), and from the first ten thousand until the second (which is twenty thousand), and from the first one hundred thousand until the second (which is two hundred thousand). From the second ten (which is twenty), until the tenth ten (which is one hundred) it counts with *–mey–*, which is the same from the second one hundred (which

> is two hundred), until the tenth one hundred (which is a thousand), and from the second ten thousand (which is twenty thousand), until the tenth ten thousand (which is 100,000) and from the second one hundred thousand (which is two hundred thousand), until the tenth one hundred thousand (which is one million). Everything is seen as done in the same manner, if one takes time to understand the method. Although, because of interaction with the Spaniards, many count as we do, and therefore they say: *dalawangpuó at isa*, twenty and one. *Sangdaan at lima*, one hundred and five. *Limangdaan dalawang puo at lima*, five hundred and twenty and five, similarly with the other numbers.

The observations of Totanes are important because they call attention not only to the exact mathematical pattern but also to the aesthetic beauty involved in the way this enumeration system was conceived and practiced.

The basic building block was the simple numbers from one through nine. Complex numbers are built upon these simple numbers with strict mathematical and grammatical consistency. Numbers from 11 through 19 have their rules based on the prefix *labi*–. This pattern of constructing numbers through the prefix *labi*– is consistently carried out for 101, 1,001, 10,000, etc. As soon as twenty is reached, another set of rules for the construction of numbers take over, the rule of using the prefix *may*–, as well as a different way of looking at the counting process. Counting is no longer merely adding to the previous number but is a process of heading towards another quantity, which in this case is the nearest multiple of ten, as in *maykatlongisá* is one towards the number thirty. The process of counting with the prefix *may*– is repeated for the multiples of 20, 200, 2,000, etc. Another way of forming numbers, representing yet a third method and mental framework, is the counting of the different multiples of ten. Whereas the prefixes *labi*– and *may*– respectively represent the notions of greater than (>) and the idea of heading towards a greater quantity, in this case the nearest multiple of ten, the multiples of ten themselves represent a different idea of counting and involves a different mental process. As pointed out earlier, both the simple and the succeeding multiples of ten imply a process of multiplication. We thus have three different mental processes working within this enumeration system.

A graphic analogy may be proposed to further describe this ancient enumeration system. Imagine a figure of concentric circles of ever increasing radii drawn in three different colors in an ever-repeating pattern. At the center of the circles is also the point of origin of the number line. As one continues to extend the number line and counts through to ever higher numbers, one also passes through the different three–colored concentric circles, where the three–color pattern represents the three different rules for constructing numbers. Counting numbers is not merely going through a straight line but is also an exercise in constructing a system of three–colored concentric circles whose colors vary periodically. While most other enumeration systems would merely have straightforward repetition of patterns, the ancient Tagalog system of counting is quantum arithmetic. No other enumeration system has such sophistication.

This was an enumeration system which was complete, as it could express any number it desired; mathematically and grammatically consistent, as mathematical patterns and grammatical structure strictly followed rules; efficient, since it made full and efficient use of repeating patterns; and aesthetically impressive because of its level of sophistication. Furthermore, the implied processes of addition and multiplication contained in the formation of the counting words are also totally consistent with our modern understanding of the idea of place value in arithmetic.

The Last Number: *Isang Bahala*

Did the counting process ever end? Apparently Old Tagalog, as well as Old Malay, did not subscribe to the notion of mathematical infinity but instead had what is called "limit numbers" or numbers beyond which one stops at counting. For ancient Tagalog number crunchers, this limit number was a thousand *yuta*, 100,000,000, or one hundred million. Beyond this number was an inconceivable mathematical void which no one crosses. Fray Francisco Blancas de San Jose fortunately was able to record and preserve this mathematical notion in his 1610 *Arte y reglas de la lengua Tagala*:

> . . . fang libong yota y millares de yota no fe conoce: fino dizen fang bahala, que es dezir un que fe yo, ycao na ang bahala, echa por effos trigos de Dios: que ya no fe puede pensar.[65]

. . . one thousand *yota* and thousands of *yota* is not known. Instead they say *sang bahala*, which means "What do I know? I leave it up to you [Bahala ka]. What can I do? Of these things one can no longer conceive."

Notes

1 Morris Kline, *Mathematical Thought from Ancient to Modern Times*. Oxford: Oxford University Press, 1972.

2 Howard Eves, *An Introduction to the History of Mathematics*. New York: Holt, Rinehart, and Winston, 1961.

3 Morris Kline, *Mathematics for the Nonmathematician*. New York: Dover Publications, 1967, p. 11.

4 Gaspar de San Agustin, *Compendio del arte de la lengua tagala.* Manila: lmprenta de "Amigos del Pais," Calle de Anda, 1703, 1787, 1879, p. 115.

5 San Agustin, *Compendio*, p. 117.

6 Eladio Zamora, O.S.A. *Las corporaciones religiosas en Filipinas*, Valladolid: Imprenta y Libresia Religiosa de Andrés Martin, 1901, reprinted in Emma Blair and James Robertson, *The Philippine Islands, 1493–1898*, 1907b, vol. 46, p. 347.

7 Vicente Barrantes, *Apuntes interesantes*, Madrid: Impr. de El Pueblo, 1869, reprinted in Blair and Robertson, 1907a, vol. 45, p. 292.

8 Jesus T. Peralta, "Petroglyphs and Petrographs," in *Kasaysayan*, 1998, vol. 2, p. 135.

9 Francisco Colin, *Labor evangelica de los Obreros de la Compañia de Jesus en las lslas Filipinas*. Madrid: 1663, vol. 1, reprinted 1904, p. 25.

10 Miguel de Loarca, "*Tratado de las islas Filipinas*," written around 1580, reproduced in Juan Jose Delgado, *Historia general sacro-profana, politica y natural de las islas del poniente llamadas Filipinas* (Manila: Juan Atayde, 1892), p. 383.

11 The detailed discussion of the historical and anthropological significance of the LCI is found in Antoon Postma, "The Laguna Copper-Plate Inscription (LCI): A Valuable Philippine Document," *National Museum Papers* vol. 2, no. 1 (1991), pp. 1–25. Also cited in E. P. Patanñe, *The Philippines in the 6th to the 16th Centuries*, pp. 83–103. Quezon City: LSA Press, 1996.

12 For the present purposes we use the translation provided by Patanñe, *The Philippines*, p. 85. Postma, the first translator of the LCI, provides four different translations of the document, reflecting his growing understanding of the text.

13 Juan Francisco de San Antonio, "Cronicas de la Provincia de San Gregorio Magno," chap. 45, reproduced in Blair and Robertson, 1906, vol. 40, pp. 358–59.

14 The notorious practice of so-called "Filipino time" or habitual tardiness, now slowly disappearing, might in fact be traced or at least related to this ancient manner of telling time: I am not late for a meeting, despite having arrived past the agreed hour, because the meeting had not yet started when I arrived.

15 Pedro Serrano Laktaw, *Estudios gramaticales sobre la lengua tagalog*. Santa Cruz, Manila: Imprenta de Juan Fajardo, 1929, p. 360.

16 Juan de Plasencia, "Customs of the Tagalogs," Manila, 1589, reproduced in Blair and Robertson, 1903b, vol. 7, pp. 188–89.

17 William Henry Scott, *Barangay: Sixteenth-Century Philippine Culture and Society*. Quezon City: Ateneo de Manila University Press, 1994, pp. 123–24.

18 San Antonio, "Cronicas," pp. 359–60.

19 Mateo Sanchez, *Vocabulario de la lengua Bisaya*, Manila, 1711, as cited in Scott, *Barangay*, p. 123.

20 Juan de Plasencia, "Customs of the Tagalogs," pp. 189–90.

21 Serrano Laktaw, *Estudios gramaticales*, p. 360.

22 Francisco Ignacio Alcina, *Historia de las islas e indios de Bisayas*, 1668, as cited in Scott, *Barangay*, p. 123.

23 Miguel de Loarca, "Relation of the Filipinas Islands," 1582–1583, reprinted in Blair and Robertson, 1903a, vol. 5, p. 165.

24 Scott, *Barangay*, p. 123, cautions us and qualifies Loarca's account: "What Loarca called months were seasonal events connected with swidden farming: they do not appear in early Visayan dictionaries as the names of months, nor do any other names."

25 Ibid., p. 124.

26 Scott reminds us that the system, like other calendar solutions proposed by other civilizations, has some significant problems: ". . . the Visayan month was a lunar month—29-and-a-half days and 43 minutes, to be exact—so twelve of them did not add up to a year, but only 354 days. They were therefore not the equivalent of months in the western calendar, which are arbitrary divisions unrelated to the moon, approximately one-twelfth of a solar year of 365 days." Ibid., p. 122.

27 Ibid., p. 121.

28 San Antonio, "Cronicas," p. 359.

29 Scott, *Barangay*, p. 121.

30 San Antonio, "Cronicas," p. 359.

31 Ibid.

32 Ibid.

33 Scott, *Barangay*, p. 121.

34 Serrano Laktaw, *Estudios gramaticales*, p. 361.

35 Ibid.

36 Serrano Laktaw, *Estudios gramaticales*, p. 357.

37 San Antonio, "Cronicas," p. 363.

38 Sebastian de Totanes, *Arte de la lengua tagala y Manual tagalog para la administracion de los sacramentos*. Binondo: lmprenta de Miguel Sanchez y Ca., Sampaloc, 1745.

39 Totanes, *Arte de la lengua tagala*, p. 118.

40 Ibid., p. 121.

41 San Antonio, "Cronicas," p. 363.

42 Ibid., p. 361.

43 Ibid.

44 The first three rows are from Serrano Laktaw's tables (*Estudios gramaticales*, p. 358), while the last three are reconstructed from data provided by Scott.

45 San Antonio, "Cronicas," pp. 361–62.

46 Table constructed from data provided by Scott, *Barangay*.

47 San Antonio, "Cronicas," p. 358.

48 The basic table is from Serrano Laktaw (*Estudios gramaticales*, p. 358), but the two items with asterisks are additions to the Serrano Laktaw table from data provided by San Antonio.

49 San Antonio, "Cronicas," p. 362.

50 Serrano Laktaw, *Estudios gramaticales*, p. 358.

51 This section reproduces all of the examples found in Serrano Laktaw's *Estudios gramaticales*, pp. 352–56, since this important study methodically describes the old system but yet has never been given the attention it deserves. Other sources apart from Serrano Laktaw are indicated accordingly. We follow Serrano Laktaw's practice of marking with an asterisk ancient usage that is still conserved in present practice.

52 Paul Schachter and Fe Otanes, *Tagalog Reference Grammar*. Berkeley: University of California Press, 1972, p. 200.

53 Serrano Laktaw, *Estudios gramaticales*, p. 352.

54 The linker –*ng* undergoes phonetic changes and becomes *labindalawa*, *labing-anim*, *labimpito* depending on whether the first consonant of the following simple number is bilabial, dental/alveolar, or velar/glottal; see Schachter and Otanes, *Tagalog Reference Grammar*, pp. 200–201, for the linguistic rules governing these changes.

55 Schachter and Otanes, *Tagalog Reference Grammar*, p. 200.

56 Serrano Laktaw, *Estudios gramaticales*, p. 357.

57 Gaspar de San Agustin, *Compendio del arte de la lengua tagala*. Manila: Imprenta de "Amigo del Pais," Calle de Anda, 1703, 1787, 1879, p. 115.

58 Sebastian de Totanes, *Arte de la lengua tagala y Manual tagalog para la administracion de los sacramentos*. Binondo: Imprenta de Miguel Sanchez y Ca., Sampaloc, 1745.

59 Serrano Laktaw, *Estudios gramaticales*, p. 357.

60 T. H. Pardo de Tavera, *El sanscrito en la lengua tagalog*. Paris: lmprimerie de la faculté de médecine, 1887, p. 34.

61 Ibid., p. 55.

62 Ibid.

63 Ibid., p. 26.

64 Totanes, *Arte de la lengua tagala*, p. 103.

65 Francisco Blancas de San Jose, *Arte y reglas de la lenqua Tagala*. Bataan, 1610, p. 266.

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———. 1907a. *The Philippine Islands, 1493–1898*, vol. 45: *1736*. Cleveland: Arthur H. Clark.

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Editor's Note

This essay was prepared for a graduate course on the History of Mathematics offered by Dr. Mari-Jo P. Ruiz, which the late Mr. Ricardo Manapat took in the second semester of academic year 2000–2001. Dr. Ruiz, who had kept the original essay, broached its possible publication. *Philippine Studies* is very grateful to Mrs. Angelita L. Manapat and her children, Maria Teresa Manapat Hayakawa, Maria Lourdes Manapat de Pala, Maria Cristina Manapat-Sims, and Jose Alfredo Manapat, for permission to publish it in this journal. Except for minor editorial changes, such as ensuring consistency of the author's style and verifying the exactness of cited extracts, this posthumous publication reproduces the original paper in the manner it was composed, for which reason the journal's house style has been suspended. The reference list, however, has been reformatted to conform to the journal's style.

Ricardo Manapat was director of the Records Management and Archives Office (National Archives of the Philippines), from 1996–1998 and 2002–2008. In 1976 he obtained his A.B. Philosophy degree and graduated with Departmental Honors from the Ateneo de Manila University, where he became an Instructor in the Philosophy Department from 1977–1979. He completed his M.A. in Spanish in Rizal Studies at the University of the Philippines in 2004. In 2005 he began his PhD studies at La Trobe University, where the following year he was awarded the Commonwealth International Student Scholarship as well as the DM Myer Medal for most outstanding graduate student. He was in the midst of doctoral research when he died of myocardial infarction on 24 December 2008. He was 55 years old. He authored *Some are Smarter than Others: The History of Marcos' Crony Capitalism* (New York: Aletheia Publications, 1991) and was editor-in-chief of the "Smart File," *Smart File Magazine* Animal Farm Series.