HAWAIIAN NUMBER SYSTEMS

By BARNABAS HUGHES, O.F.M.
California State University
Northridge, CA 91330

English-speaking visitors to the Hawaiian Islands delight in interspersing Hawaiian words with their own language. The islands are perhaps the only place in the United States where the English-speaking *haole* (Caucasian) can mix a different language with one's own and be understood. The tourist easily learns many Hawaiian words and phrases from pamphlets available in stores and hotels. For instance, in Honolulu, directions are *mauka* ("toward the mountain"), *makai* ("toward the sea"), *ewa* ("toward the west") or *Diamond Head* ("toward the east") rather than compass oriented. Everywhere in the islands, *aloha* means "love," "greetings," "welcome," or "farewell," depending on circumstances of time, place, and persons.

The mathematics teacher from the mainland soon discovers the Hawaiian words for counting numbers (table 1). The pronunciation of several words is very similar to the English pronunciation: *tausani* sounds like "thousand," *miliona* like "million." Moreover, *haneri* is phonetically close to "hundred." These Hawaiian words seem to echo American words; or, are they really American words made more liquid under languid, tropical skies?

The list also betrays an obvious decimal formation—is that the way it was? In fact, what is known about Hawaiian number words? What was their origin? What influenced their development? Answers to these questions form an interesting chapter in the history of number systems.

The history of Hawaiian number systems follows closely the history of the people of the islands. The latter is customarily divided into two phases, one before and the other after the arrival of Captain James Cook in 1778. The period before witnessed the Polynesians sweeping across the South Pacific in huge sailing canoes from Asia by way of the Malay Peninsula and Java. Their easterly migration took them through Tahiti and the Marquesas until they reached Hawaii during the fifth century A.D. Bringing families and food, livestock and languages, the various Polynesians merged their cultures into what is now recognized as the Hawaiian culture.

A certain affinity among the number words of the inhabitants of Polynesia was found and reported by John Davis in the *Hawaiian Spectator*, January 1839. He listed the number words from one to ten as used by the inhabitants of Tahiti, the Marquesas, Rapa, Rarotongan, New Zealand, and the Easter and Hawaiian islands. There is no significant difference among these number words, regardless of their place of use, except for ten: the Hawaiians use *'umi*, the others use a variant of *angauru*. The latter word, however, is known to

TABLE 1

kahi	1	ono	6
lua	2	hiku	7
kolu	3	walu	8
hā	4	iwa	9
lima	5	'umi	10
umi-kumana-kahi			11
umi-kumana-lua			12
.			.
.			.
.			.
iwakalua			20
iwakalua-kumana-kahi			21
.			.
.			.
.			.
kanakolu	30	kanawalu	80
kanahā	40	kanaiwa	90
kanalima	50	haneri	100
kanaono	60	tausani	1 000
kanahiku	70	miliona	1 000 000

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the Hawaiians in the form *anahulu*, which means a "decade" or "ten-day week."

The references report older counting words than those listed in tourist books. The evidence hinges on the word for *four* and multiples of it by ten. *Kauna* is the earlier term for four; *ka'au* antedates *kanaha* for forty. In groups, therefore, the number words are as follows:

ahā kahi (four ones)	= kauna	(4)
'umi kauna (ten fours)	= ka'au	(40)
'umi ka'au (ten forties)	= lau	(400)
'umi lau	= mano	(4 000)
'umi mano	= kini	(40 000)
'umi kini	= lehu	(400 000)
'umi lehu	= nalowale	(4 000 000)

For instance, the following are found:

12 = ekolu kauna	(three fours)
20 = elima kauna	(five fours)
760 = ekahi lau me iwa ka'au	(one four hundred and nine forties)

Numbers too large to count were often denoted by *kinikini* or *lehulehu*. In fact, the modern mathematical term "infinity" is represented by *nalowale*, which also means "out of sight."

Why the emphasis on "four"? The answer is difficult to come by. Alexander (1968 reprint) remarks that the significance of four arose from the custom of counting fish, coconuts, taro and such by taking a couple in each hand or by tying them in bundles of four. The Hawaiian philologist Rubellite Kawena Johnson thinks that the importance of the number four may have come from basket weaving and astronomy. To begin a basket, two pieces of *pe'a* (i.e., "cross") were placed at right angles to one another; hence, there are four times two strands (or 8). This figure is found likewise in the constellation *Hānai-a-ka-mālama*, Southern Cross, called *Peka* (i.e., cross, "8") in Taumotuan.

Prior to the introduction of writing by the missionaries, computations were performed mentally or by counting on fingers. The number words simply indicated the results of computations. Hawaiians who were particularly skilled in computing were much in demand by the *ali'i*, local chief. Their job was to keep an account of tapas, mats, fish, and other property that the chief would distribute to dependents. Thus, before the arrival of missionaries, there was little, if any, interest in an academic appreciation of arithmetic.

The first missionaries arrived from New England on 31 March 1820. Within two

Brief Guide for Pronouncing Hawaiian Words

The Hawaiian alphabet has only twelve letters: seven consonants (*h, k, l, m, n, p, w*) and five vowels (*a, e, i, o, u*). The consonants are pronounced as in English, except for *w*. When *w* follows *e* or *i*, it is given a *v* sound. Otherwise *w* is generally pronounced as in English. The vowels are pronounced thus:

a . . . uh (in unaccented syllables)
ah (in accented syllables)
e . . . eh
ah (when marked $\bar{e}$ or $\bar{E}$)
i . . . ee
o . . . oh
u . . . oo.

If a bar is over a vowel, the vowel sound is held just a bit longer. If an inverted comma, as in *ali'i*, precedes a vowel, the breath is stopped momentarily (glottal stop). Syllables consist of (1) a consonant and vowel—in that order or (2) a single vowel. There are no diphthongs. The accent ordinarily falls on the next to last syllable, unless the final vowel has a bar. In this case, it gets the accent. For instance, *kanahā* (40) is pronounced *káh-nuh-hÁH*, and *kanakolu* (30) is pronounced *káh-nuh-kȮH-loo*. Spoken properly, the Hawaiian language seems like gentle waves; the syllables rise and fall.

years they had learned the Hawaiian language, reduced it to literal form based on Latin pronunciation, and begun printing books. The native Hawaiians were eager to learn and flocked to the missionary schools. Education brings change. Among the first things that changed were the Hawaiian number words.

Using the vocabulary at hand, the missionaries reformed the number system from a mixed base-four-base-ten to a strict base-ten structure. The method was easy because Hawaiian terms were at hand. The multiple prefix *kana* meaning "tens of" was placed before *kolu* to form *kanakolu* (30), before *hā* to make *kanahā* (40) and so on up to *kanaiwa* (90). This was an easy change, for the Hawaiians were used to thinking in terms of "tens." Their year was based on ten-day periods, *kana ʻekā* was ten bunches of bananas, and *kana ko ʻoluna mai* was ten two-man canoes. Larger numbers, of course, were adopted from English: *haneri* for hundred, *tausani* for thousand, and *miliona* for million. Thus arose the counting number words found in tourist books today.

There is little, if any, evidence that words for fractions existed in any Polynesian language before the arrival of missionaries. They supplied the gap. In Tahiti the missionaries introduced the word *afa* (half) and *tuata* (quarter); in Hawaii they created *hapa* for half. In time this became a general word for *part*, which is conjoined with the counting numbers to form whichever fraction one desires. It must be noted that these words for fractions are conceptually different from *pakahi, palua*, and so on. The latter signify a separating of a quantity into groups or a counting by ones, by twos, and so on.

Changes in number words were not restricted to counting. The missionaries also changed the names of the days of the week. Before the arrival of the missionaries, the calendar was a lunar calendar consisting of twelve or thirteen months of twenty-nine or thirty days, depending on the year. Each day had its own name taken from the number order of the night before—names that suggested deities. The missionaries adapted Latin terminology for the days of the week. Where Monday is *feria prima* in Latin, Tuesday *feria secunda*, and so on; in Hawaiian, Monday became *Pō ʻakahi*, night the first; Tuesday was *Pō ʻalua*, night the second; and so on. Sunday received a special name, *Lāpule*, day of prayer. Nor did the ancient month-names escape the changes wrought by the missionaries. Indeed, the missionaries brought not only a new religion but also the trappings of a new culture.

There is no evidence that the change was immediate or universal. Chamisso (1837, pp. 55–57) noted that an early translation of the Bible into Hawaiian employed the modified base-four system. For example, the passage from Exod. 7:7 was "elua kanaha makahiki o Mose a elua kanaha makahiki o Aarona a me kumamakolu" (Moses was twice forty years old and Aaron twice forty and three). Kanepuu (1867) wrote of conflict between older and younger Hawaiians. Some of the latter knew only the decimal system, whereas the older men and women who sold fish and produce in the markets reckoned in the old way with specific terminology. *Iako* (40) was used only for counting tapas and canoes; *kaʻau* (40) was used with fish. But change did come.

Clark (1839) justified the change to the decimal system with the remark that the new method of computation is better adapted (!) to mathematical calculations. Could the reason for his judgment have been his own experience with problems employing numbers expressed only in base ten? Nonetheless, he recognized the natural ability of the Hawaiians for mathematics. For he wrote that they were fond of arithmetic, both mental and written, and were capable of making good progress not only in common arithmetic but in the higher branches of mathematics.

Opportunities to learn and use the "new math" of the early 1800s were at hand. Primary arithmetic books had been published for children as early as 1833 (*He helu kamalii*, Oahu, 2d ed.), and in the same year

and place a text on mental arithmetic was published (*He helunaau*). A more challenging work was available at least by 1870 when C. J. Lyons translated and published James B. Thomson's *Higher Arithmetic (Ka Hainahelu Hou; Oia Hoi Ka Arimatika Kulanui)*. At the beginning of this last text, the translator placed mathematical terms in Hawaiian and English, in parallel columns. The Hawaiianization of certain English terms is obvious: *akioma* ("axiom"), *avakupoi* ("avoirdupois"), *bila* ("bill of goods"), *teroe weta* ("troy weight"). Mathematical terminology had arrived.

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