Kaho'olawe Island Conveyance Commission

Consultant Report No. 9

Kaho'olawe's Potential Astro-Archaeological Resources

By:
Rubellite Kawena Johnson

PRELIMINARY ARCHAEOASTRONOMICAL INQUIRY INTO SOME KAHO'OLAWE SITES CONDUCTED IN FIELD EXCURSIONS IN MARCH AND SEPTEMBER 1992 FOR THE KAHO'OLAWE CONVEYANCE COMMISSION:

Report of the Consultant, Rubellite Kawena Johnson, submitted March 1993

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SUPPLEMENTAL SUMMARY

Preliminary Archaeoastronomical Inquiry Into Some Kaho'olawe Sites Conducted In Field Excursions in March and September 1992 For The Kaho'olawe Conveyance Commission: Report of the Consultant, Rubellite Kawena Johnson, submitted March, 1993.

The objective of the archaeoastronomical inquiry was to determine:

(1) Review and identify places which have archaeoastronomical significance;

(2) Review the literature or oral history to the extent that potentially productive sites from that literature would be examined in situ to record applicable data by means of observation and/or measurement by appropriate means, i.e. bearings of azimuth of alignment of markers (ahu, kuahu);

(3) Locate the selected sites in the field to collect data;

(4) Analyze data as it relates to archaeoastronomy (astro-archaeology) on Kaho'olawe and make appropriate recommendations for historic preservation and future study.

(5) Submit reports as required.

The questions for research supplied by the commission were:

(1) Are there astro-archaeological resources on Kaho'olawe?

(2) Any recommendations for historic preservation?

The literature and oral history reports supplied by other consultants' reports [Reeve, Silva] on legendary places and traditional migration literature of the pre-contact period were reviewed, and the following sites were selected for field study:

(1) Site 108 [McAllister] Upright slabs.

(2) Site 348A Hakioawa: Ku'ula fishing shrine on bluff.

(3) Site 348 Hakioawa: Hale o Lono heiau.

(4) Site 560 Hakioawa: Hale o Papa heiau.

(5) Site ___ Pu'u Moa'ulanui/Lua Makika (1477 ft. height)

(6) Site ___, Pu'u Mo'iwi adze-making center
(7) Site ___, Ke-ala-i-Kahiki (compass stones)
(8) Site ___, Pu'u Moa'ula-iki and Keaweiki Rock (bell stone)

All of the sites listed above were visited except Site 108, and recommended sites (below) are left to future field work:

(9) Keanapou Bay (ko'a shrines)
(10) Kamohio Bay (ko'a shrines)
(11) Lae o ka 'Ule, north point/cape of Kanapou Bay
(12) Ka-lua-o-Kamohoali'i.

Two field excursions were executed, one in March, 1992 commensurate with the vernal equinox, and another in September, 1992 close to the autumn equinox. The principal investigator/consultant regrets missing the solstitially productive times for alignment studies at these sites, but that would have been on the agenda had scheduling allowed those visitations.

The first field excursion in March 1992 was the subject of a very preliminary field-note report to the commission entitled "Archaeoastronomical Potential of Traditional Sites on Kaho'o-lawe," March 1992 Equinox gleaned from two sites, the alignments of which seemed to corroborate each other, at Pu'u Mo'iwi and at Site 348A Hakioawa, Ku'ula fishing shrine with views of ahu pillars on a southern ridge about two valleys away, probably Oawawahie (yet undetermined), with sextant and Opti-Compass readings (azimuth) from 162°S to 172°, suggesting meridian and north to south polar transit observations and alignments at both sites. The second field excursion was limited to confirming the location of the ridge ahu sites seen from Hakioawa Site 348A. A pencil drawing by resource person Inez Ashdown, whose long association as a resident of Kaho'olawe gives her recollections of sites and people on the island great credibility was used, with some margin of error with regard to the identification of the pillar ahu as the Makali'i and Makakilo sites to which her drawing relates that may the actual ahu seen from Hakioawa ridge. On the assumption that these are indeed the referenced ahu sites (Makali'i/Makakilo), the second report has been prepared.

The interpretations of the data collected from both excursions in March and September are provided in the second report, "Preliminary Archaeoastronomical Inquiry Into Some Kaho'olawe Sites Conducted In Field Excursions In March And September, 1992 For The Kaho'olawe Conveyance Commission".

Reference sources and other pertinent studies which are correlative background to assess these Kaho'olawe archaeo-astronomical surveys, of an extremely preliminary nature, are supplied in the Appendix to the reports and contain the following:

1. Da Silva, Armando and Rubellite K. Johnson, "Ahu a 'Umi Heiau, A Native Hawaiian Astronomical and Directional Register," Ethnoastronomy and Archaeoastronomy in the American Tropics, edited by Anthony F. Aveni and Gary Urton, in the Annals of the New York Academy of Sciences, Vol. 385, 1982:313-331.

2. Broda, Johanna, "Astronomy, Cosmovision, and Ideology in Pre-Hispanic Mesoamerica," Ethnoastronomy and Archaeoastronomy in the American Tropics (see above): pp. 81-110.

3. Johnson, Rubellite K., (Excerpt] "The First Age," from The Kumulipo Hymn of Creation, 1981: 21-25.

4. Johnson, Rubellite K., "The Spider Ecliptic in the Pacific and the Role of the Knotted Cord in its Distribution," (mss.) Pacific Science Association VI Inter Congress, "The Pacific, Bridge or Barrier," Valparaiso-Vina Del Mar, Chile, August 7-10, 1989; 33 pages.

5. Grimble, Rosemary [Excerpt] "Maneaba", from Migrations, Myth and Magic from the Gilbert Islands, 1972 (London), pp. 207-220.

6. Johnson, Rubellite K., "The Dynamics of Space and Time in Hawaiian Spirituality," (mss.) East-West Center Institute of Culture and Communication conference, "An Exploration of Contemporary Spirituality: Axial and Primal Traditions," Burns Hall, June 10-13, 1991; 27 pages.

7. Johnson, Rubellite K., Letter to Conrad re "Discrepancies in Hawaiian Calendars," [mss. typecript];29 pages.

The reports, in which collected data are assembled and interpreted from the Kaho'olawe field excursions, confirm the value of the island of Kaho'olawe for its strategic location in relation to other Hawaiians Islands in relative proximity [Maui, Lana'i, Molokini, Moloka'i, Hawaii]. Moa'ula-nui is a place from which the northeast to eastern horizon has an uncluttered view from Lana'i to East Maui, with open corridor views to Moloka'i through the channels and an open corridor to the northern pole across the isthmus of Maui between Ma'alaea/Kihei to Wailuku. From Kealaikahiki on the extreme west side of the island facing west/southwest, the coast is open in a sweep from west to east, from Hanakanae'a to Kamohio to Lae o Kaka. The mountains of East Maui, inclusive of Haleakalā at 10,000 feet elevation, are not obstructive, inasmuch as they constitute a range against which to observe the north/south progress of the sun's passage along the ecliptic and the major/minor swings of the moon, although these kinds of observations were not attempted during the field trips.

The report's assessment of the interpreted field data positively supports the importance of Kaho'olawe as an archaeo-astronomically productive island with regard to the sites visited and the sites selected but not yet visited. It poses that the alignments (potential) between 162° and 172° SE from Hakioawa to the rising point of Canopus [cp. 165° Pu'u Mo'iwi] within a 15° radius on either side of the meridian (0°N to 180°S] is commensurate with the "Big Dipper Clock" [Ursae Majoris] observation strategy which is the basis of the "hour-circle" measurement through a 45° polar ambit of the Big Dipper equalling a three-hour passage of time.

The report also includes data measurements and alignments which serve to demonstrate that other heiau in the Hawaiian Islands seem to have the same emphasis of alignment to the meridian and circumpolar ambits of the Dipper in the north to circumpolar arcs between the rising stars of the pole from 162° (Canopus) to west (setting). Ahu a Umi Heiau (studied by Da Silva) and Kukaniloko Birth Heiau (studied by Harry Kurth) have been used to supply the corroborative data for Kaho'olawe sites studied.

The coordination of zenith passages of the sun to anti-zenith passages of the Pleiades seem to be suggested by the Makali'i ahu alignment to Makakilo in line with Canopus rising at 162°S.

Given the dates for the 500-year periods between zenith star positions of the Pleiades at the latitude of Moa'ula-nui/ Makali'i ahu, Kaho'olawe, by Peter Michaud of Bishop Museum's Kilolani Planetarium, showing the Pleiades in the zenith between 992 - 1492 A.D. before Arcturus as the zenith star since 1492 A.D. to the present, it is likely that Kaho'olawe would have been visited by Polynesians who may have associated Makali'i ahu with the zenith/antizenith passages of the sun and the Pleiades twice in the year.

Finally, with regard to Keaweiki Rock at Pu'u Moa'ula-iki, it is highly likely that if the rock was ever intended to be astronomically functional, then the diagonal across the bell stone (Keaweiki) points to the azimuth of Capella setting [310° NW] with reciprocal at Fomalhaut?, rising at 138° SW.

Dr. Edward Stasack's report on petroglyph study in the field is appended to the second report, and Dr. Aki Sinoto's input may also follow.

So far as recommendations are concerned, as for the future of archaeoastronomical field study on Kaho'olawe or preservation of pertinent sites, let it be said that the island being thus far productive with respect to this preliminary effort, that it is hoped that more can be and should be done to keep this kind of study alive, and it goes without saying that to do so implies that the sites be preserved.

This consultant thanks the following for their contribution to the field effort:

Lt. William Klein, celestial navigator USN for his expertise and field note preparations; Abraham Pi'ianaia for his expertise in navigation and whole-hearted support for this endeavor; 'Ilima Pi'ianaia for her interest in Kaho'olawe and in this particular kind of field focus on navigation/astronomy; Captain Milton Roth, Lt. Vern Young, and Senior Officer Edward Mrosczak for their sustained logistical support for material provisioning and transportation to and from sites and on-base administration of supplies and scheduling; Rowland Reeve, for on-site and pre-

preliminary guidance on archaeological sites with maps/charts and other necessary information pertinent to sites visited; Aki Sinoto, for his work at Makakilo and Makali'i sites on the second excursion, Hardy Spoehr for all the help with getting to and around Kaho'olawe to do this investigation, Dr. Edward Stasack for leading the petroglyph study, and Meleanna Meyer for her contribution to the petroglyph team in the field as well as her gift of photographs. A special thanks is due to Dr. Stasack for his written report and also to Mrs. Harry Kurth for the gift of Major Kurth's data on Kukaniloko Heiau.

This is just a beginning. It is recommended that someday in the future, some real archaeoastronomers are brought to Hawaii to do a survey of all of the sites in the Hawaiian Islands. Thankyou, Kaho'olawe Conveyance Commission, once again, for the invitation, support, and interest which you have shown in the island and all of the personnel involved.

Rubellite Kawena Johnson

Rubellite Kawena Johnson, Consultant
March, 1993

P.S. I have said nothing in these reports about use of Kaho'olawe for the teaching of navigation and astronomy, and I believe that the island itself is not the basis of learning of either discipline, but rather, is a matter of development of the human mind to understand the science of time and space. In all likelihood the island will be there long after human beings are gone, and until then it should be productively used to promote human survival and understanding. In the preparation of this report and in the field, two arts were predominantly used, so far as the detecting of celestial alignments is concerned. One was naked-eye astronomy, given the basic understanding that comes with knowing how stars behave from evening to morning and how their circuits are related to the movements of the sun, moon, planets. The other was the skilled use of the sextant, which is the modern-day mechanics of celestial navigation, including the tables of the Nautical Almanac for 1992.

The use of basic navigational knowledge when applied to sailing is an admirable kind of performance, requiring real knowledge of the sky, the ocean, and how a moving vessel behaves through the open seas and around land mass. Arranging a scheme to make landfall, whichever techniques are used, naked-eye astronomy and dead-reckoning or the nautical almanac, charts, and the sextant is part of the equipment one needs to find one's way from one port to another, one land mass to another.

As testimony to the acquisition of such skills as those mentioned above and also, as a praiseworthy effort to exemplify to the successful kind of training and application, I include the charts used by two schools of navigation:

(a) that used by the Hōkūle'a voyager, Nainoa Thompson showing how the Polynesian/Micronesian skills of naked-eye navigation have been revived, and:

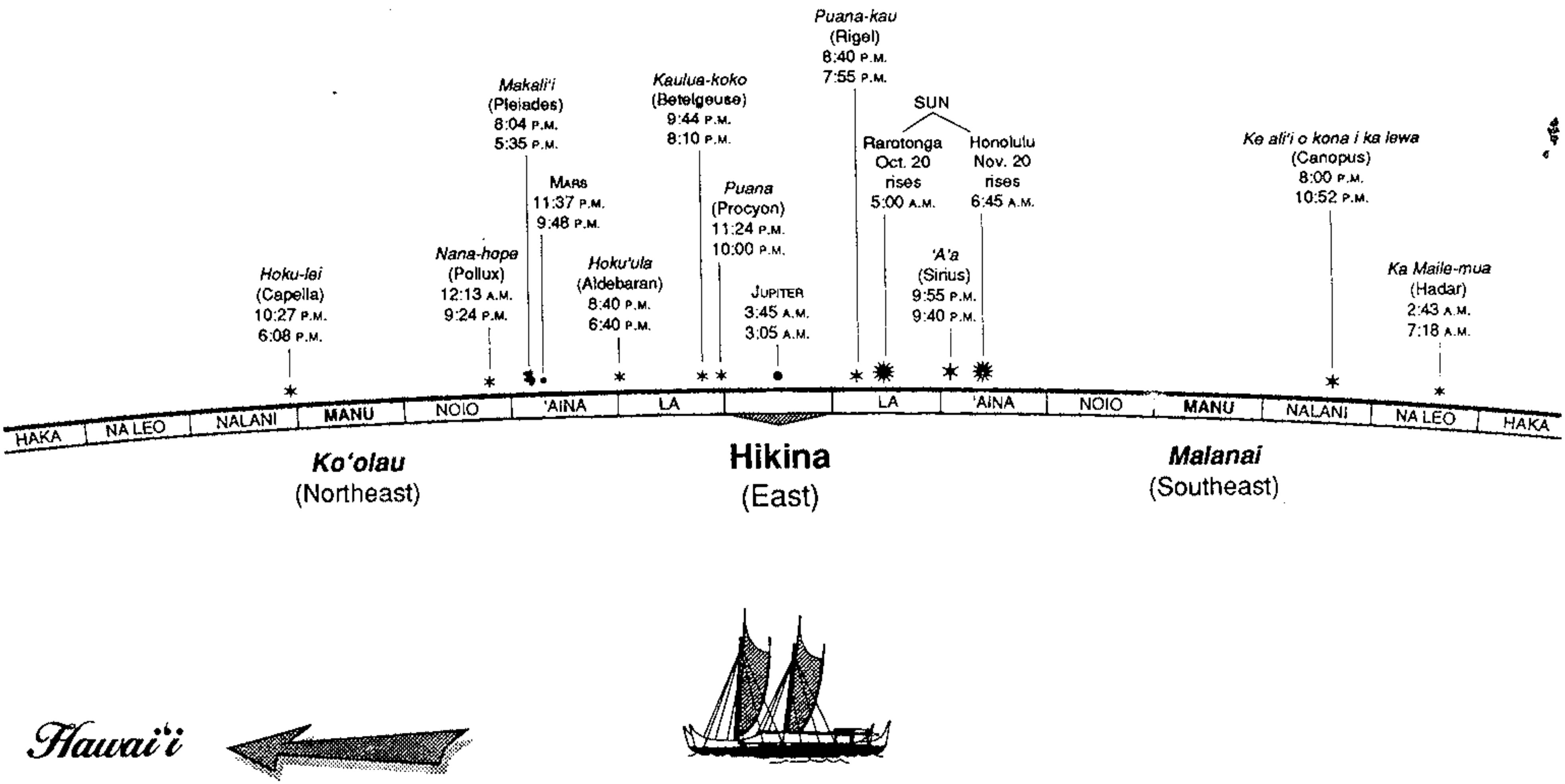
(b) that used by a young navigator, also of Hawaiian/Scandinavian ancestry, using the tools of modern celestial navigation (sextant).

Attached are the horizon star charts used by the Hōkūle'a on its most recent voyage across the equator and the charts of star-fixes used by Moani Johnson on the voyage of the Kawamee in 1978. The charts show the route she took between Hawaii and Kaho'olawe, January 1978. She was 18 years old.

In our present world today we need to know and to appreciate the skills represented by both methodologies, that which was here before Captain James Cook, and that which we have learned to apply since he came. Our future would be better served if in redirecting Kaho'olawe's purpose, we keep in sight the whole, rather than only a part, of our society's combined learning.

Eastern Horizon—Rising Stars

Rarotonga to Hawai'i
October 20 to November 20, 1992



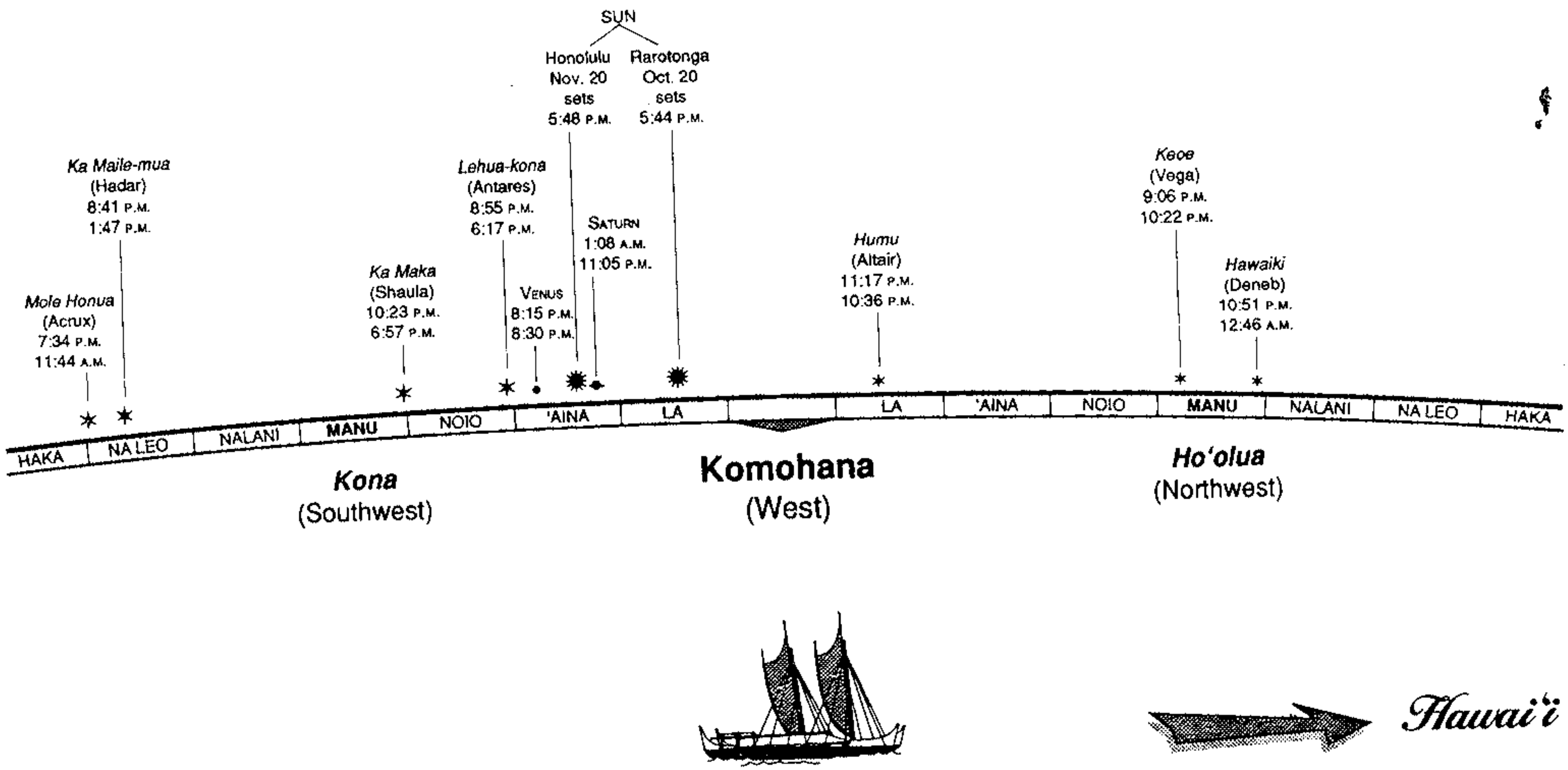
Note: The times given below each star are rising times. The time listed first indicates when the star will rise in Rarotonga on October 20. The second time specifies when the star will rise in Honolulu one month later—the approximate length of the voyage. There is very little change in where the stars will rise along the horizon in the latitudes covered during this voyage. The sun, however, comes up farther south due to the approaching winter in Hawai'i..........

Hawai'i Maritime Center

Western Horizon—Setting Stars

Rarotonga to Hawai'i

October 20 to November 20, 1992



Note: The times given below each star are rising times. The time listed first indicates when the star will rise in Rarotonga on October 20. The second time specifies when the star will rise in Honolulu one month later—the approximate length of the voyage. There is very little change in where the stars will rise along the horizon in the latitudes covered during this voyage. The sun, however, comes up farther south due to the approaching winter in Hawai'i. Many stars that the navigators could use when leaving Rarotonga are obscured by sunlight as the canoe nears Hawai'i, e.g., *Ka Maile-mua* (Hadar)................

Hawai'i Maritime Center

30 JANUARY 1978

MERIDIAN PASSAGE OF THE SUN

2200 146°37.5 S17°33.6 (-0.7)
2233 154°52.5 S17°33.7
33 8° 14 +.4

AFTERNOON SUN

15 15 14
10 1
25 15 15

191°39.2 S17°31.5 (-0.7)
3°48.8 -.2
195°28.0 S17°31.3
154°28.0 W18°W
41°W 36.0
36°35 (34) N129W
-20 231
36° 15

36° 38
-34
+15.0
36° 49.6
36° 15
35 T

B

30 JANUARY 1978

CAPELLA 18 34 34 — 49 39
+10 +1 — -3.3
28 34 35 — -0.8
190° 01.5 — 49 35
9° 40.2 — 49 22 039
199° 41.7 — 13 T
155° 41.7 W 18°N
43°

ALDEBARAN 18 36 12 — 66° 08
+10 +1 — -3.3
28 36 13 — -0.4
190° 01.5 — 66° 04
9° 04.7 — 66° 27 090
199° 06.2 — 23 A
155° 06.2 W 19°N
44°

ACHERNAR 18 37 29 — 12 49
+10 +1 — -3.3
28 37 30 — -4.2
190° 01.5 — 12 41.5
9° 24.0 — 12 51 171
199° 24.5 — 10 A
155° 24.5 W 19°N
44°

SIRIUS 18 38 34 — 24° 13.5
+10 +1 — -3.3
28 38 35 — -2.1
190° 01.5 — 24° 08 118
9° 40.3 — 24° 07
199° 41.8 — 1 T
155° 41.8 W 19°N
44°

31 JANUARY 1978

VISUAL FIX

KAHOOLAWE 2155 073

LANAI 2157 337

20° 32.7 N
156° 50.3 W

1 FEB 78

☽

10	01	52
10		1
70	01	53

34° 22.5
-33.3
56.9
4.4
34° 50.5
35° 13
23A

179° 41.7 (+7.7) 316° 03.7 (+0.4) 59.0
0° 27.0 0.2
10.2 315° 08.9 36° 16 (-3) 428W
200° 09.1 -3 232
158° 07.1 W 21° N 35° 13
42W

☉

70	02	43
10		1
20	02	44

34° 37.5
-3.5
+14.9
34° 47.1
34° 40
09 T

116° 36.4 317° 01.3 60.7)
0° 41.0 0.0
117° 16.4 317° 01.3
158° 16.4 W 21° N
41E
34° 41 (-40) N130E
1
34° 40

PRELIMINARY ARCHAEOASTRONOMICAL INQUIRY INTO SOME KAHO'OLAWE SITES CONDUCTED IN FIELD EXCURSIONS IN MARCH AND SEPTEMBER, 1992 FOR THE KAHO'OLAWE CONVEYANCE COMMISSION: Report of the Consultant, Rubellite Kawena Johnson, submitted March, 1993.

There were two field excursions conducted by the Kaho'olawe Conveyance Commission in the past year to determine the archaeoastronomical (astroarchaeological) potential of the island's traditional and other related archaeological sites. The first of these was conducted in March, 1992 and was the subject of a preliminary field-note and partly handwritten report to the commission in April [Johnson, R. Kawena, Archaeoastronomy of Kaho'olawe I, Preliminary Report, April, 1992, 24 pages, containing a number of photographs (34 illustrations)] targeting sites visited, some of which were productive while others were unintentionally missed, although sought for (Ke-ala-i-Kahiki compass rocks).

I mentioned in that report that although the team was encouraged by the sighting of two ahu on a ridge to the southeast of Hakioawa heights (above the Hale o Lono heiau) toward the evening of the second day, they may not be true archaeological, man-made sites. Given, however, celestial navigator William Klein's sextant readings (azimuth readings) for potential alignments along several key bearings determined by the position of prominent altar stones [Pu'u Mo'iwi] and the observation locus [Hakioawa ridge, with natural stone platforms] to the key horizon stone fixtures, it was necessary to return in September (8th to 10th) to readjust our findings by doing two things:

(1) Check the photographed "pillars" (ahu) sighted to see if they were man-made or natural stone objects, and

(2) Ascertain their precise location so that the ridge name and location could be more accurately determined.

This report will emphasize the results of the second, return field trip in September, 1992 three days before Hurricane 'Iniki struck.

Members of the second team, including the principal investigator, were:

(1) Rubellite Kawena Johnson, Hawaiian traditions consultant for archaeoastronomical potential
(2) Aki Sinoto, archaeologist
(3) Edward Stasack, petroglyph art researcher
(4) Meleanna Meyer, assistant petroglyph art researcher
(5) Vern Young, military chaperone
(6) Rowland Reeve, anthropologist, Kaho'olawe 'Ohana
(7) Hardy Spoehr, executive assistant, Kaho'olawe Conveyance Commission

This team divided into two groups:

(a) Johnson, Sinoto, and Young to check the ridge site ahu for archaeological validity, by which is meant that the ahu are man-made props or natural rock outcrops, the former indicative of human occupation;

(b) Stasack, Meyer, and Reeve, petroglyph sites.

Hardy Spoehr divided his attention between the two groups and saw to their safety and provisioning.

(A brief report from the petroglyph team written by Dr. Edward Stasack is appended to this report. Another to be written by Dr. Aki Sinoto on his archaeological findings for the ridge site will be added, whether in the context of this report or with the archaeology of Pu'u Mo'iwi, which site was visited in the March field trip and revisited in September by team (a) above with Hardy Spoehr.

(This report will only highlight the overall interpretation of the findings from the two brief excursions. The preceding field-note report, except for important excerpts and illustrations pertinent to this report, is relegated to the Appendix).

Interpretation

(1) The projected "potential" alignments, suggested in the preliminary report of April 1992 and reinvestigated by Sinoto/Young/Johnson in September 1992, appear to be aligned with the Hakioawa ridge site. The lower pillar is a natural outcrop of rock, while the upper one is an ahu of Hawaiian type on a site, the disposition of which indicated it had been built and used by Hawaiians. The existence of this upper ahu, due to its ridge alignment:

(a) to the lower outcrop pillar rock, down the same ridge, and

(b) its own view back (i.e., back-sight) to Hakioawa ridge, from which it had been first viewed in March

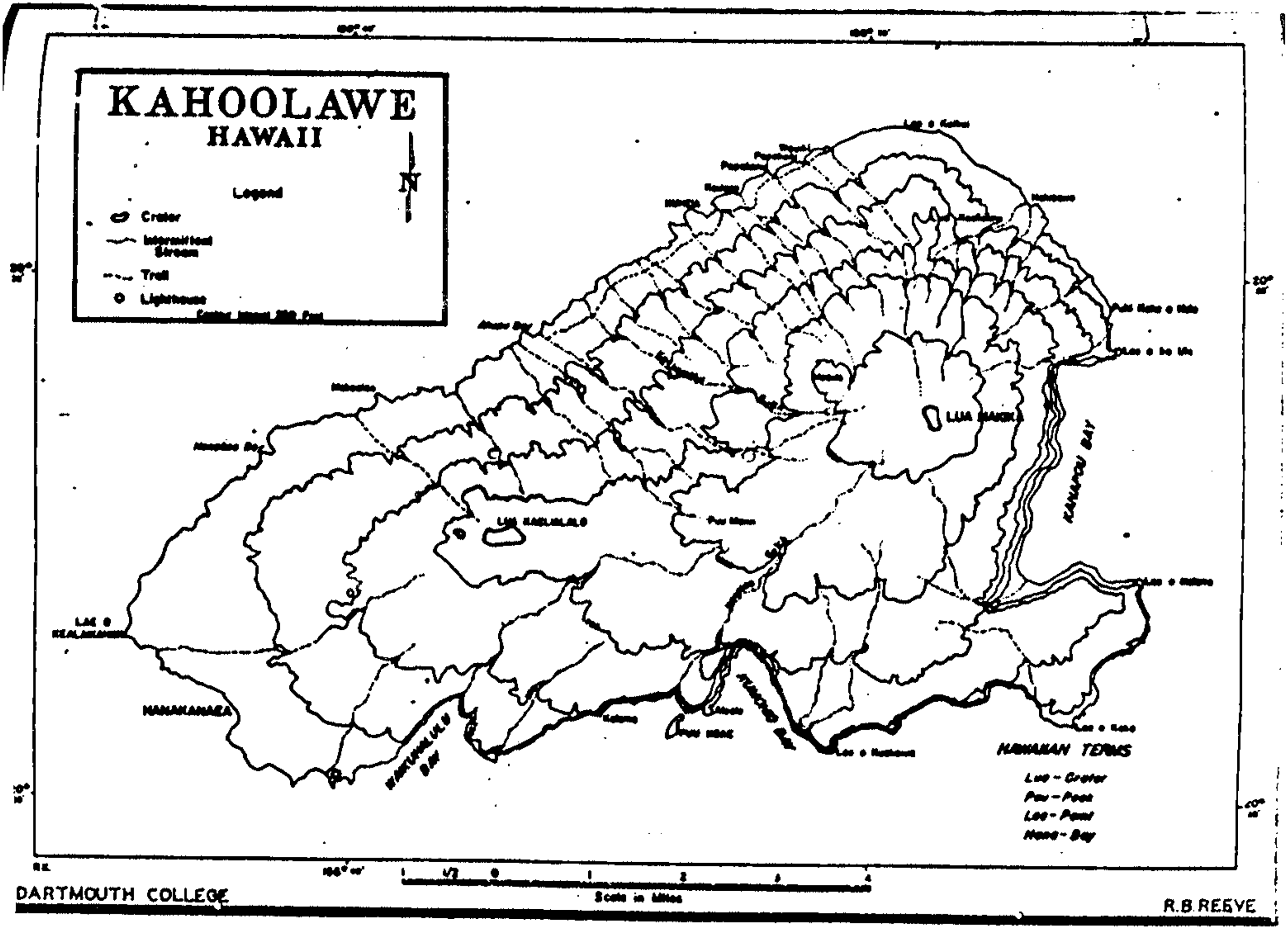
may indicate that sighting of the large stone outcrop against the southeastern sky by the March team may have/likewise invited the curiosity of the early builders of the upper ahu.

Reeve and Spoehr had made available a hand-drawn map pencilled by Inez Ashdown, in addition to aerial topographic overhead photographs that pinpointed the ridge location of the ahu, specifically two sites that Ashdown's notes evidently had referred to with the names:

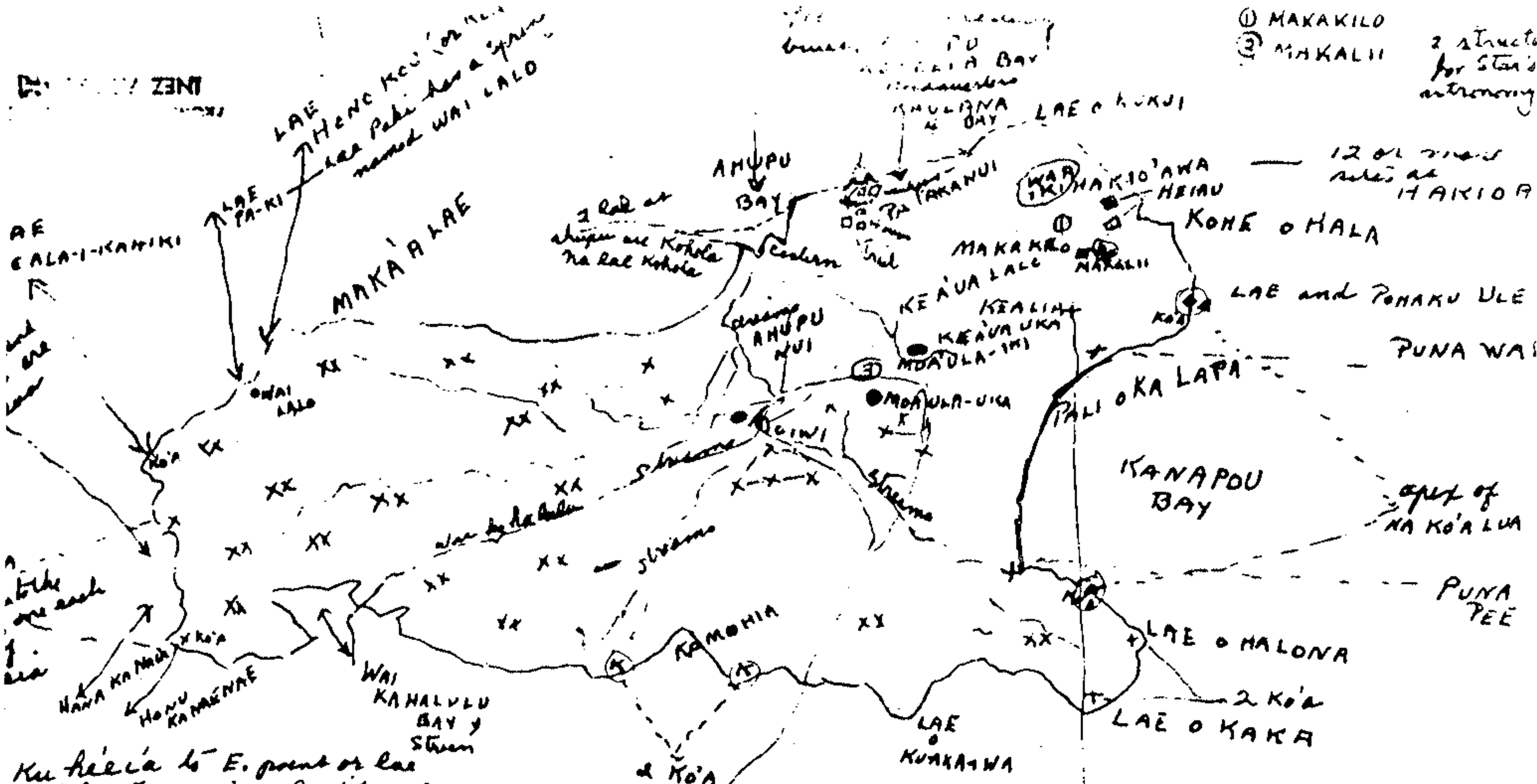
[1] Makali'i, for the lower pillar outcrop, and

[2] Makakilo, the ahu pillar site above.

At this writing the archaeological and historical findings have not yet confirmed if these two things are the Makali'i and Makakilo of the Ashdown drawing, but this investigator is proceeding on the assumption that these are the intended sites as such and has interpreted the alignments suggested in the April report in accordance with objective findings and the Ashdown information. Even if information to the contrary shows that neither pillar formation, natural or man-made, is either Makali'i or Makakilo, the ahu are still in a position favoring potential celestial alignment. If it should turn out that



KAHOOLAWE
HAWAII
N
Legend
Crater
Intermittent Stream
Trail
Lighthouse
LUA MAKIKA
LUA KEALIALALO
KANAPOU BAY
HAWAIIAN TERMS
Lua - Crater
Puu - Peak
Lae - Point
Hono - Bay
NANAKANAKA
Scale in Miles
1
1/2
0
1
2
3
4
DARTMOUTH COLLEGE
R.B.REEVE



Kea hele'a to E. point or Lae Kea Hikiku. To west side, Lae Hilu'ula are points of east or birth, and west or death

XX – In the XX areas were house sites, sea shells showing people cried opihi up.

at Puu Mo'iwi was the big quarry, the "glass" etc.

should be moo not meaning ancestral "bones" or "treasures" literally, regard bones

③ PLENTY HOUSE SITES SHELLS etc. down to Kamohia side

④ 4 Kaulana Bay has the stone-paved well

Hakioawa was a paved trail, large ..., 3 smaller "heiau" around ...iki. Some said wa-'ai hi'i to mean home of high chief habitations. " " wai-iki or little water

XXX Adze quarry was up in here and pieces were scattered about. Also other tools, sinkers, pounders

Kealia means any swampy place.

2 "lakes" up here during & after rains streams flowed from there

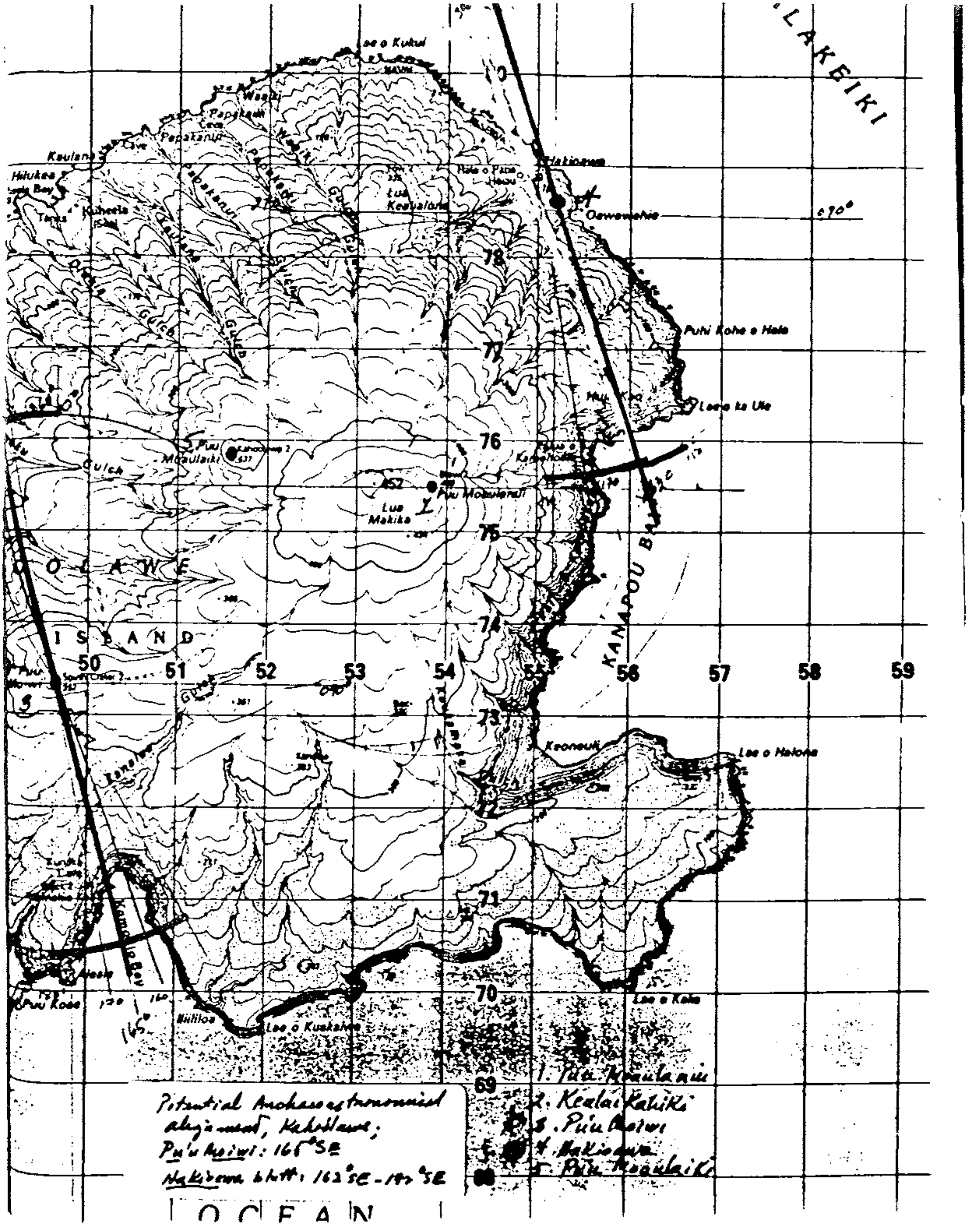
... 10 ko'a

these are the Makali'i (Pleiades) and Makakilo (Sky-watcher/ Observer, as of stars/fish/weather phenomena) rocks of the Ashdown drawings, so much the better, and with regard to that likelihood, the investigator has asked Bishop Museum Kilolani Planetarium astronomer, Peter Michaud, to contribute an interpretation of Makali'i (Pleiades) for the Kaho'olawe parallel of latitude consistent with known astronomical events or pertinent facts.

Given then, the follow-up treatment of the previous March 1992 observations and on-site inspections of the theoretical "archaeoastronomical" possibilities from data culled from Pu'u Mo'iwi and Hakioawa, with additional insights gained from the "next ridge over" in September 1992, which ahu names of the specific sites I am also not yet sure of until Aki Sinoto and other archaeologists have, in fact, accurately identified them, this investigator is prepared only to suggest that the following points of interpretation are possible:

(1) The projected alignments between the Hakioawa ridge locus (March 1992) and the ahu on a southeastern ridge (September 1992), when adjusted in practical terms for sailors, rather than astronomers, extend through a nexus on the coast between Lae O Ka Ule and Ka-lua-o-Kamohoali'i to Lae o Halona, to the azimuth bearing, or toward the rising position (southeast) of any important star or stars rising and setting on either side of the meridian position of the Southern Cross, 162°S [Makali'i] to 172°S [Makakilo], such as Canopus (165°S) [*Note, the Southern Cross at 180°S], the pillar rock called Makali'i (for our purposes) bearing 162°S close to the rising point of Canopus.

(2) Upon the above, it may also be inferred that, along the north/south meridian axis to Lae o Kaka means that at that southern coastal extremity, which is Lae o Kaka itself, a star-gazer (kilo hōkū) may watch the timed swing of that track of arc, which coincides with the timed swing



ʻALAKEIKI
Lae o Kukui
Waaiki
Papakaiki
Cave
Papakanui
Kaulana
Hiluke
Kuheeia
Hakioawa
Hale o Papa
Heiau
Lua Keaualono
Oawawahie
Puhi Kohe o Hale
Lae o ka Ule
Puu Moaulaiki
Gulch
452
Puu Moaulanui
Lua Makika
Kanapou
KANAPOU BAY
K O ʻ O L A W E
I S L A N D
Keoneuli
Lae o Halona
Lae o Kaka
Lae o Kuakahe
Niiiiloa
Puu Koae
Kamohio Bay
O C E A N
50
51
52
53
54
55
56
57
58
59
78
77
76
75
74
73
71
70
69
Potential Archaeoastronomical alignment, Kahoolawe;
Pu'u Moiwi: 165°SE
1. Pu'u Moaulanui
2. Kealaikahiki
3. Pu'u Moiwi
4. Hakioawa
5. Pu'u Moaulaiki

of the Big and Little Dippers (Na Hiku/ Hōkūpa'a) at the north pole, or to any other tracked arc which would represent a timed movement of fixed stars, not only rising from east to west, but also in a north-to-south alignment through the meridian as they come to zenith through the night.

(3) It would then appear that the night sky, as observed by the kilo hōkū, was not merely observed but also measured by a fixed radian measure for the arc of time which today's specialists would call "hour circles", and for which the Hawaiian measurement can be known only by the analogy which I have drawn on the Kaho'olawe map also provided by Reeve, which, for the proportion used on paper,as timed to aeronautical standards [i.e., by "squares" indicating minutes (?) across and for which we must use another ruler of time] is a radian measure of 5 and 1/2 inches or 14 centimeters. An adjustment would be required for the map space squared out to indicate the rate of time at which the earth is moving to cover the distance traveled by the celestial body, rather than the rate at which a moving body, such as an airplane, moves over the area in miles on Kaho'olawe. That rate would be revealed for the given stars observed, such as Canopus, to rise and set through the night between sunset and sunrise, i.e., which stars aligned in either pole were on the opposing horizons east and west and also in the meridian through the night, if the night were measured in quarters, every three hours, or thirds, every four hours, or sixths every two hours. Every twelfth of a day and a night equals 1/12 day, or one hour, and in one hour the sky moves 15° of arc, so that 15 degrees times 24 hours in one day equals the time it takes the earth to move 360° of its circle of daily rotation time. What kind of information does an observer obtain, one whose professional predecessors as kahuna kilo hōkū did watch Na Hiku circuit the north, and Kape'a (Southern Cross) and Ali'i-o-Kona-i-ka-Lewa (Canopus) south?

What would they have learned? With regard to the poles north and south, and the circumpolar motion of stars/constellations nearest the poles and transits of other stars across the meridian formed between the poles over the locus of the observer, there is a phenomenon called the "Big Dipper Clock," which forms a consistency of cyclical circumpolar motion, well-described in Experiments in Space Science [Peter Greenleaf, 1981: 24-34, appended after page 8, intra].

How was the radian measure of the ecliptic (sun's annual time) determined and adjusted to a proportional fraction of sidereal time relative to the rotation of the earth's axis, determined by the meridian drawn between the poles, Polaris at the north now, and Southern Cross at meridian (or Canopus)? A radian measure was deduced for Ahu a 'Umi Heiau by Da Silva ["Ahu a 'Umi Heiau, A Native Hawaiian Astronomical and Directional Tropics, 1982: 322-328, appended to this report in Appendix, pages 324-325]. Is that computation a contrivance of mathematical application read into the heiau, or is it corroborated at other ritual sites, and are Kaho'olawe sites some of them?

Hawaiian tradition itself has some clues, given as cord measurements commensurate with a certain house on the heiau, described by John Papa I'i [Fragments of Hawaiian History, 1959:35] as:

(a) 2 cubits in length	= 2 ha'ilima	= 36 inches	= 1 iwilei
(b) 1 cubit in width	= 1 ha'ilima	= 18 inches	
(c) 1 cubit in depth	= 1 ha'ilima	= 18 inches	

Why this formula? Why is a "house" only 18 inches high, 36 inches long, and 18 inches wide? And why is a cord stretched in front of it at night? It begins to make sense if you take half of the house as 18 x 18 x 18 inches cube, so that the area of the surface on all sides is 18 squared, and if you know that 36 inches is somewhat relevant to the Hawaiian computation of 36 ten-day weeks to the year, and that in half that time the sun travels 18 ten-day weeks between the solstice stand-stills between the Tropic of Cancer (June/summer solstice) and Tropic of Capricorn (December/ winter solstice), creating alternate seasons between the north and south hemispheres. In addition, since the 36 inches of the length of the hale wai'ea may be situated from east to west (i.e., facing north), or from north to south (i.e., facing east), as there were two orientations of the anu'u oracle tower central to the heiau, either in the east or to the north, the cubit length of 2 ha'ilima = 36 inches = 1 yard = 1/2 anana (an anana = one fathom = 6 feet = 2 iwilei);

it follows that the 18-inch Hawaiian cubit was a proportional linear measure representing 1/2 the length of distance or time between (probably):

(1) the rising and setting of circumpolar stars = 1/2 the transit of time and distance around the earth's axis of rotation = the time on either side of the meridian between evening and morning;

(2) the length of the sun's annual motion north and south, i.e., twice the distance between the solstices;

(3) the equation of mean time that relates the two, i.e., the concept of a "mean day" as a full rotation of the earth around its axis between midnight and midnight, or from noon to noon, thus:

(4) zenith transit of the sun at noon relative to the anti-zenith transit of stars at midnight on the other side (anti-podal) of the earth, therefore:

(5) the diurnal rotation of time measured by the rate at which the earth is turning on its axis = longitude/ hour circles/ meridian transits of celestial bodies/ turning of the sky vault versus the direction in which the earth itself moves;

(6) the annual revolution of time measured by the rate at which the sun rides the horizon azimuth-by-azimuth along its north/south motion (ecliptic) to the solstitial extremes; one-half that distance = the half of the year between the solstices.

Would people whose ancestors between 5000 years had traversed the globe by boat and body between Madagascar and Easter Island east to west, and from Taiwan (Formosa) in the north to Invercargill, South Island, New Zealand, be unable to provide answers to such questions?

In this vast area and millenia of wandering over this much ground would they not be able to observe how Na Hiku (Dipper) relates to Kape'a (Southern Cross) or to Ali'i-o-Kona-i-ka-lewa (Canopus), and is not the evidence that the Hawaiians could do some intelligent adjusting of time if they kept clocks running from midnight to midnight, thus from noon to noon, so that the measurement of the day was calculated not only for sunlight as the "day" from morning to night, as the "night" from sunset to sunrise, but commensurate with the rate at which the earth turns on its axis? That they had deduced the meridian (kaupoku o ka hale) and calculated the sidereal lunation (star month) as well as the ecliptic (ke ala a ke ku'uku'u 'spider's path, the annual motion of the sun north/south between the solstices), the celestial equator (ke ala i ka piko o Wakea), the terrestrial equator (ka piko o ka honua) as well as the local meridian (ka piko o ka honua), designating the zenith as Kau ka lā i ka lolo as the zenith passage of the sun at midday?

Does this Kaho'olawe study reveal anything appropriate to the above, per alignments suggested by sextant and Opti-compass readings to various ahu pillar stones from Pu'u Mo'iwi and Hakioawa ridge, as to Canopus' rising [Makali'i ahu], the setting point of Capella in Auriga at 310°W from the bell stone at Moa'ula-iki (with reciprocal at 138°E, the rising point of Fomalhaut?)? Or are these unrealistic readings "into" the sites from projected expectations, a contrivance of intellect?

Factors in support of the Kaho'olawe results are given here:

(a) The "Big Dipper Clock" [Greenleaf]
(b) Alignment diagrams: Pu'u Mo'iwi [165°SE]; Hakioawa ridge to Makali'i ahu [162°SE], orientations to Canopus rising; [172°S], i.e., to southern polar stars/constellations, i.e., rising Southern Cross
(c) Kukaniloko Heiau (Central Oahu) study [Kurth/Johnson]
(d) Mokaena Heiau (Kuaokalā, O'ahu ([Singer]

(a) The "Big Dipper Clock" [acc. Greenleaf]

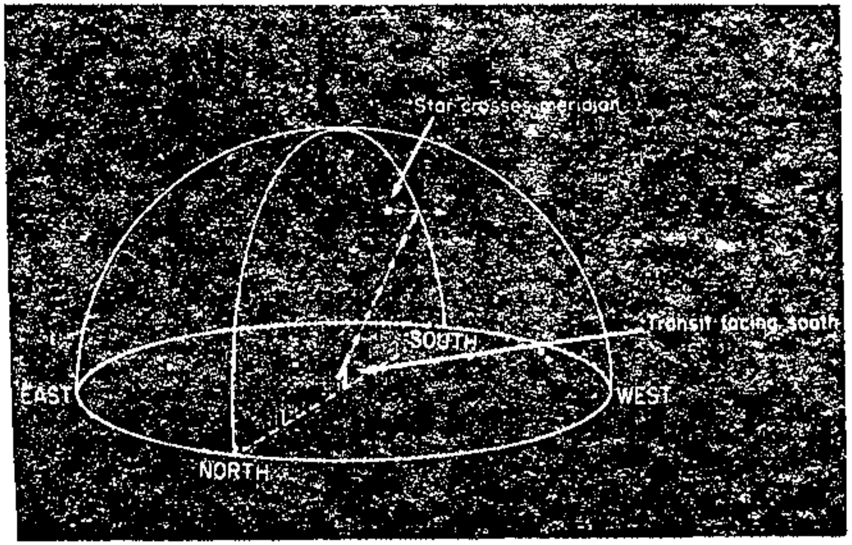


Fig. 1-15. Star in Sky Crosses Your Meridian.

OUR CLOCK IN THE SKY

Time is measured by the motions of the earth. One complete rotation of the earth spinning on its axis is equal to 23 hours, 56 minutes and 4 seconds. One complete revolution of the earth around the sun is equal to one year. The earth is a master clock and you, like the astronomer, can keep time by the stars. With a little sky watching practice, you will be able to tell time without a clock to within one half hour of actual clock time.

The North Star, Polaris, because it remains in the same place all year-round, is the center of our clock in the sky. The pointers of the Big Dipper form the hand of the clock (see Fig. 1-16). As we learned on page 17, the stars of the Big Dipper are circumpolar (they always remain above the horizon and cannot set or drop below the horizon). Fig. 1-16 shows the hand on the sky clock passing through the pointers of the Big Dipper. The pointers of the Big Dipper are the stars Dubhe and Merak (see Fig. 1-5). The Big Dipper is between the north point on the horizon and Polaris at the 6:00 o'clock position on the sky clock face in the early autumn evening.

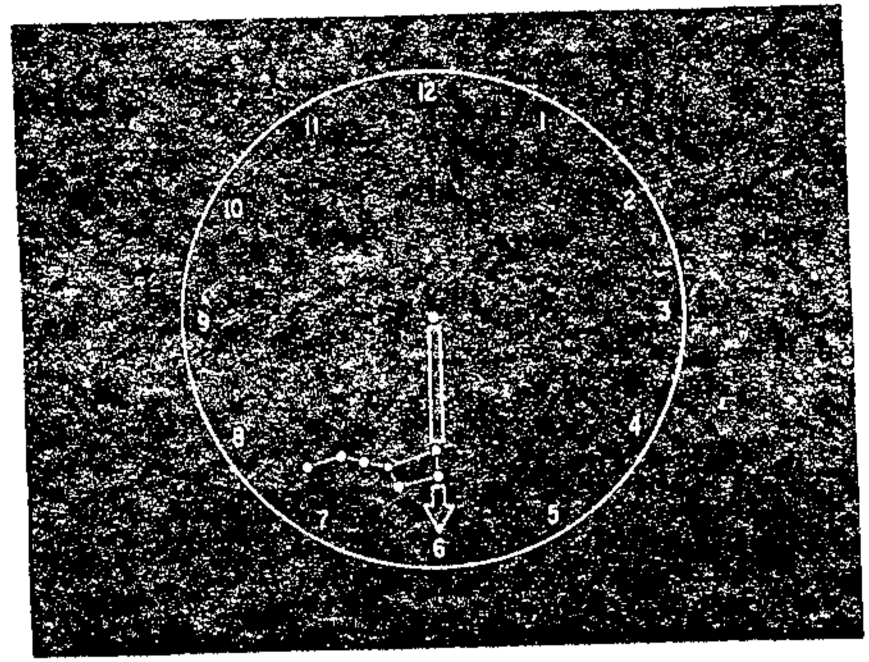


Fig. 1-16. The Hand of the Sky Clock Passes Through the Pointers of the Big Dipper.

The Big Dipper makes one complete turn around the sky clock face in one year. There are twelve months in the year and twelve positions on the sky clock; one for each month (see Fig. 1-17). Fig. 1-17 also shows the 9:00 o'clock positions of the sky clock's hand in the middle of each month. Using this diagram, you will be able to tell when it was 9:00 o'clock throughout the year.

So far, you have found the 9:00 o'clock position of the Big Dipper at midmonth throughout the year. But, you cannot tell the hour of the day without additional information. To tell time by the Big Dipper, you must know where the Big Dipper pointers should be in relation to Polaris during the given *month* and also where they should be at a *definite hour of the night* in that month. The earth spins on its axis counterclockwise once in 24 hours so that the Big Dipper will sweep around the sky clock face in one day exactly as it does

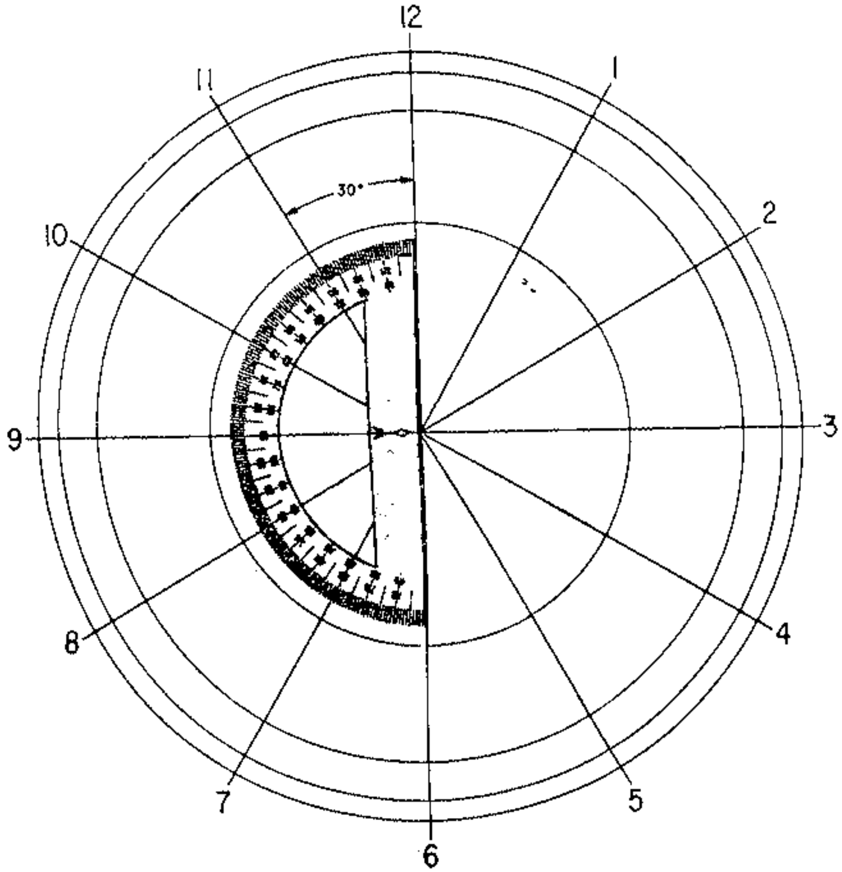


Fig. 1-18b. How to Make a Sky Clock (continued).

Project 1-6. How to Make a Sky Clock and Tell Time by Consulting the Big Dipper (continued).

4. Place the protractor where the center lines cross (see Fig. 1-18b). Mark off 30° segments and inscribe lines through center to establish accurately the 12 hours of the clock face.

5. Cut each 30° segment into two 15° segments as shown in Fig. 1-18c, to represent 24 hours. Then inscribe segments for months as shown.

6. Press wax from a dark crayon into circles and lines to make them easier to see. With marking pen write in the numbers of the clock and the name of the months as shown in Fig. 1-18c. You are now ready to use the sky clock as shown in Fig. 1-19.

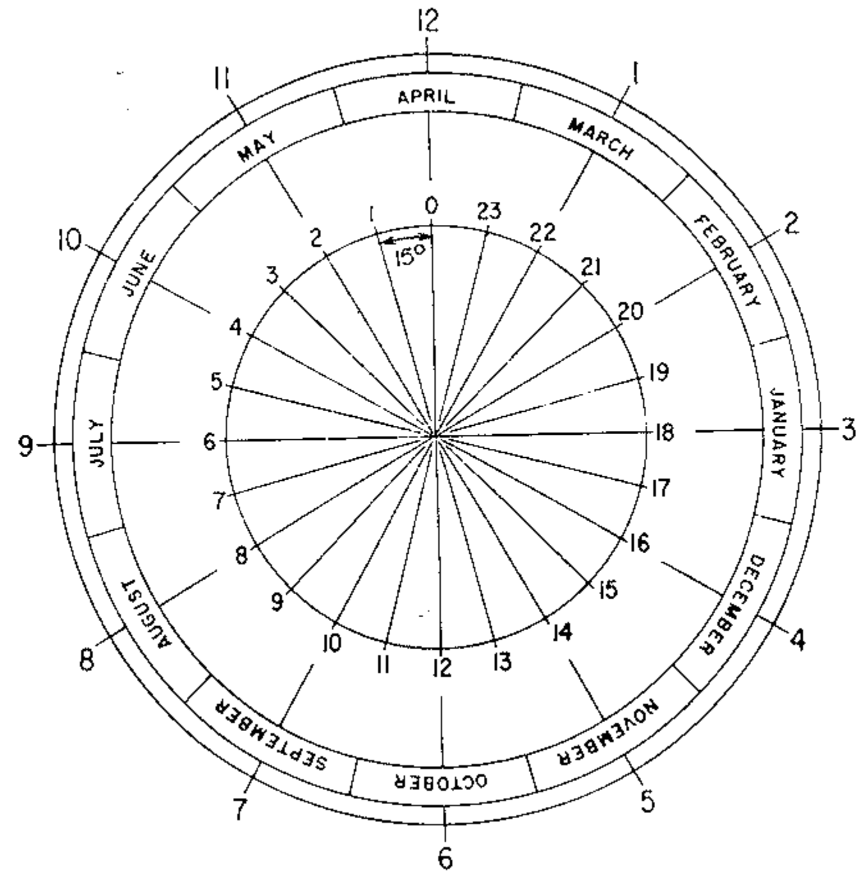


Fig. 1-18c. How to Make a Sky Clock (continued).

Since the earth turns counterclockwise on its axis once in 24 hours, the pointers of the Big Dipper will also move completely around the sky clock counterclockwise once in 24 hours. That is why the inner clock face in our special sky clock is divided into 24 parts (see Fig. 1-18c). Each segment of the inner clock represents one hour of time. However, it does not represent a specific hour of the day.

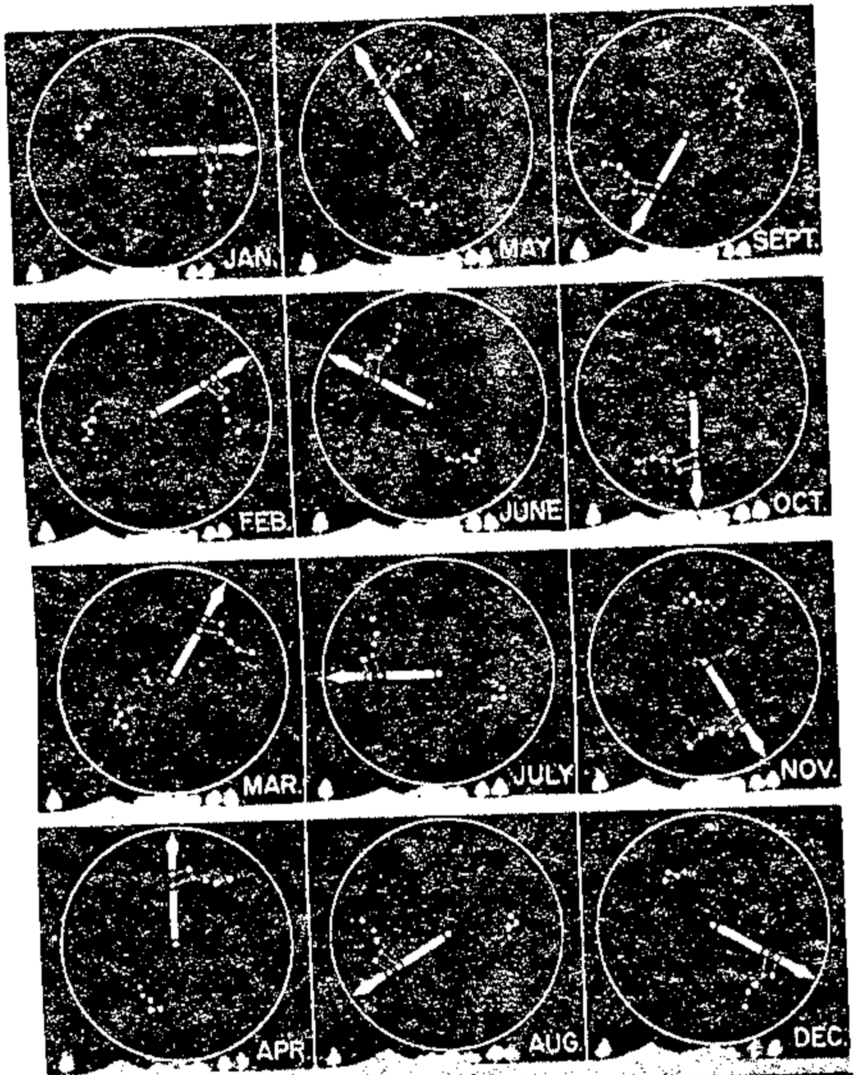


Fig. 1-17. The Big Dipper Makes One Complete Turn Around the Sky Clock Face in One Year—Shown Here are the 9:00 P.M. Positions of the Big Dipper at Midmonth Throughout the Year.

during the course of one year. To tell time at all hours, estimate where the pointers of the Big Dipper are and compare with the 9:00 o'clock reading for the month in Fig. 1-17. In Project 1-6 we build a special kind of clock face that will enable us to tell time without a regular clock.

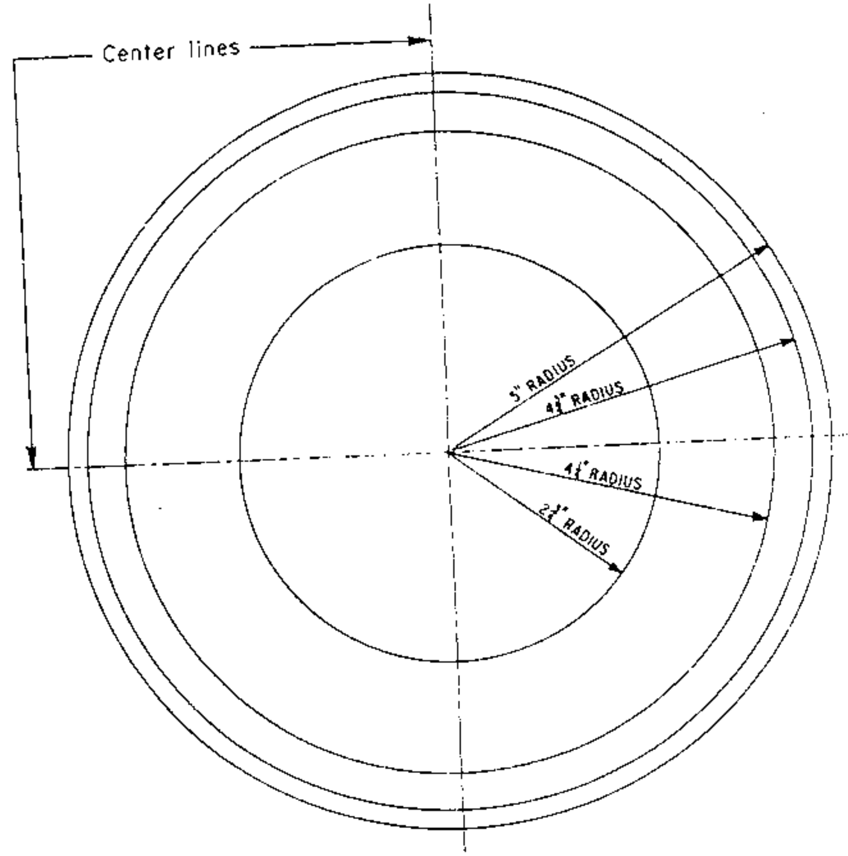


Fig. 1-18a. How to Make a Sky Clock.

Project 1-6. How to Make a Sky Clock and Tell Time by Consulting the Big Dipper.

You will need: a 12" x 12" sheet of 1/16" clear plastic available in arts and crafts shops or plastic supply house a marking pen, a dark wax crayon, a ruler, a protractor and a scriber attached to a compass to cut circles in the plastic sheet.

1. Rule two straight lines through center of plastic sheet as shown above in Fig. 1-18a.
2. Place one point of scriber in the center, where the lines cross. Set other point of scriber to a radius of 5" and scribe a circle 10" in diameter as shown.
3. Scribe another circle with a 4-3/4" radius. Then scribe additional circles with a 4-1/4" radius and a 2-3/4" radius as shown.

Fig. 1-19. Sky Clock is Sighted on Polaris.

Project 1-6. How to Make a Sky Clock and Tell Time by Consulting the Big Dipper (continued).

7. Face north in the evening. Hold the sky clock at right angles to your line of sight with Polaris as shown. Make certain that the 6:00 o'clock position on the outer circle of the sky clock points down to the north point on your horizon. Hold the sky clock so that the center of the clock is exactly in line with Polaris. Read the position of the pointers of the Big Dipper as seen through your sky clock and estimate the time. Figs. 1-20 through 1-23 are examples of how to use your sky clock to estimate time.

Example I. Let us assume that the date is July 15. You observe the pointers of the Big Dipper are on numeral 8 on the inner and outer dials of your sky clock as shown in Fig. 1-20. What time is it? You will recall that Fig. 1-17 shows that at 9:00 o'clock on July 15, the pointers of the Big Dipper will be at the 9:00 o'clock position on the sky clock face. On your sky clock, this position will be 9 on the outer dial and 6 on the inner dial (see Fig. 1-21). Therefore, if you were observing at 9:00 o'clock on July 15, the inner dial on your sky clock would read 6. However, since your reading was 8 on the inner dial, it means that the pointers of the Big Dipper have moved 2 hours **past 6** on the inner dial (9:00 o'clock on the outer dial). Therefore, the time you were observing is actually 2 **hours** past 9:00 o'clock. **Answer:** the time is 11:00 o'clock!

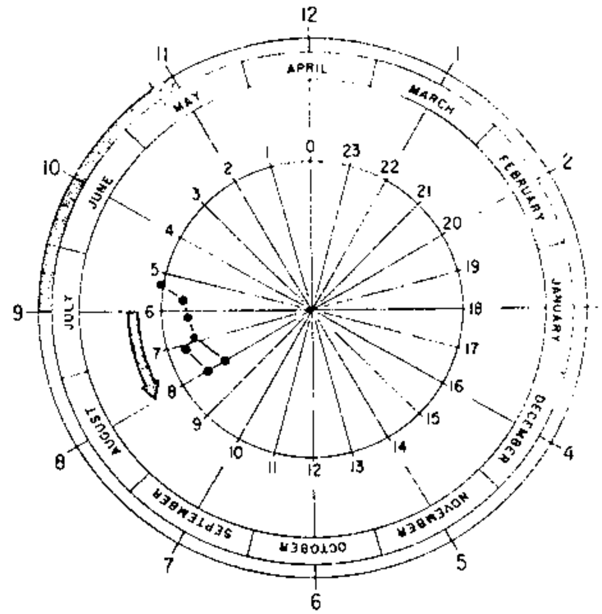


Fig. 1-20. How to Estimate Time With a Sky Clock—Example I.

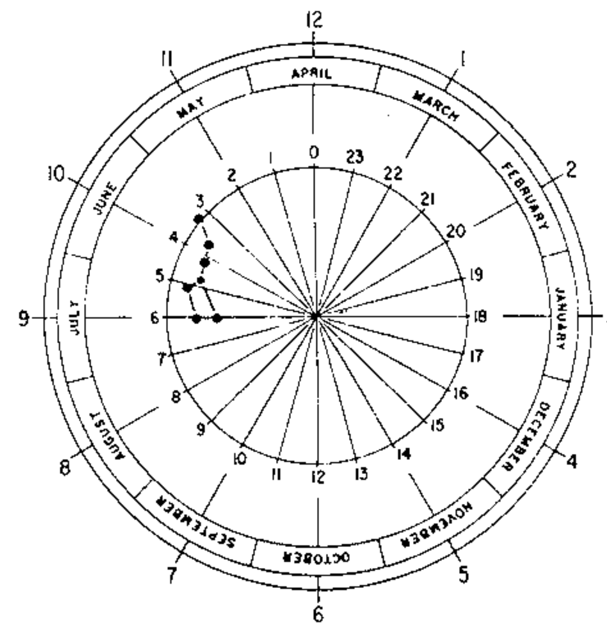


Fig. 1-21. How to Estimate Time With a Sky Clock.

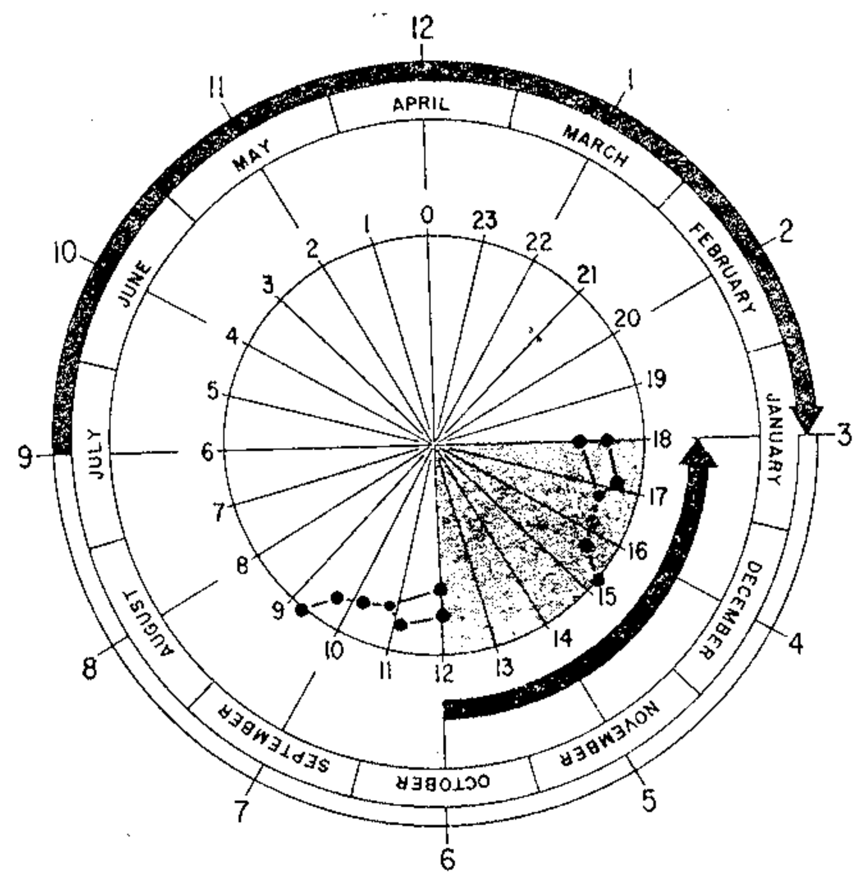


Fig. 1-22. How to Estimate Time With a Sky Clock—Example II.

Example II. Let us assume that the date is October 15. Late that night you hold up your sky clock to the sky and find that the pointers of the Big Dipper are on numeral 3 on the outer dial and on 18 on the inner dial as shown. Fig. 1-17 shows that at 9:00 o'clock on October 15, the pointers of the Big Dipper will be at the 6:00 o'clock position on the sky clock face. This 6:00 o'clock position on the sky clock is the same as numeral 6 on the outer dial and numeral 12 on the inner dial of your sky clock (see above). Since your reading showed the pointers are at 18 on the inner dial of your sky clock, it means that the time of your observation is 6 hours **past** the 9:00 o'clock position of the sky clock (18-12) or 3:00 A.M., October 16.

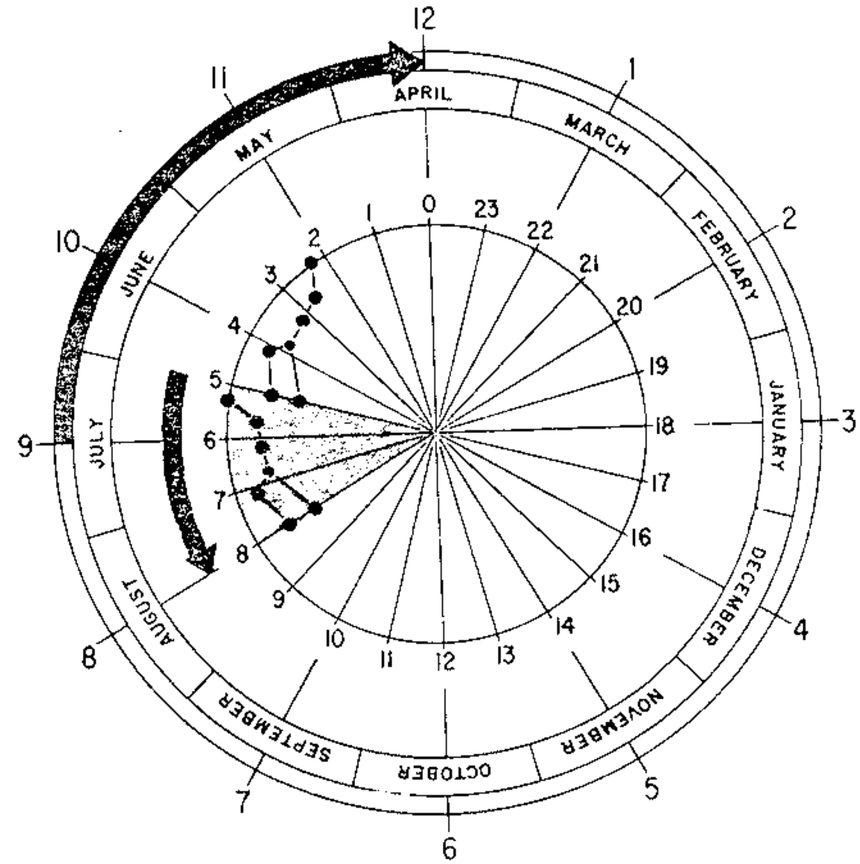


Fig. 1-23. How to Estimate Time With a Sky Clock—Example III.

Example III. Let us assume you are using your sky clock and the date is July 1. You observe the Big Dipper pointers are on numerals 8 on the inner and outer dials of your sky clock as shown. By studying the July sky clock face in Fig. 1-17, you can estimate on your sky clock that on July 1, at 9:00 o'clock, the position of the Big Dipper pointers are between 9 and 10 on the outer dial and at numeral 5 on the inner dial. With these facts in mind, what time is it? Since your observation showed the pointers to be at numeral 8 instead of 5 on the inner dial, the Big Dipper has moved 3 hours (8-5) **past** its 9:00 o'clock position. Therefore, the time is midnight!

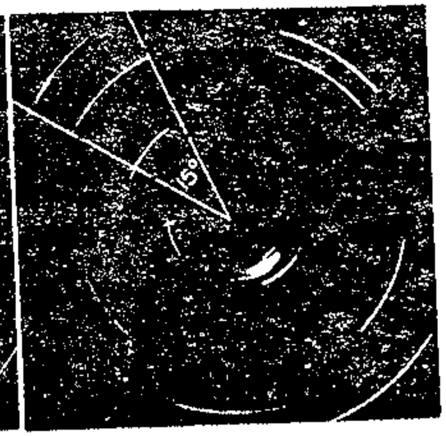


Fig. 1-24. Photo of Star Trails Showing Concentric Arcs Around Polaris.

Fig. 1-25. Photo Showing 15 Arcs Made by Star Trails in One Hour.

Photos courtesy of Yerkes Observatory, University of Chicago.

Project 1-7. How to Blaze Star Trails with a Camera.

You will need: a camera with tripod, black and white film and a protractor.

1. On a clear, moonless night set the camera on a tripod. Tip the camera so that Polaris is centered in the finder. Focus the camera for infinity.
2. Set the shutter for time exposure. Open the diaphragm to its maximum setting.
3. Set the shutter and leave the camera on for one hour. Record the time exposure was made and the number of the exposure.
4. Close the shutter, advance the film and repeat procedures in Step 2 and Step 3 several times.
5. Develop film when all exposures have been made. The developed pictures will show concentric arcs of circles around Polaris (Fig. 1-24).
6. With the center of your protractor at the center of the concentric arcs, measure the angle made by the arcs. (When the film is exposed for one hour, the arcs will be 15°.) See photo Fig. 1-25. How many degrees of arc would there be if the film was exposed for 2 hours? For 12 hours?

Note: These arcs are the trails of the circumpolar stars. As the earth turns, the images of the stars appear to move slowly across the film. Actually, your camera and film are moving with the spinning earth. The star trails are the result of the earth's rotation on its axis.

Project 1-8. How to Find the Center of the Star Trails.

You will need: Your photographs of the circumpolar star trails taken in Project 1-7 above.

1. Using any one of your photographs, estimate the center of the circles made by the star trails.
2. Find the brightest star trail nearest to this center. This will be the star trail of Polaris, the North Star.

HOW TO TRACE CIRCUMPOLAR STARS

We discovered on page 14 that the stars above the North Pole seem to move in circles around Polaris, the North Star, because of the rotation of the earth. These stars appear as points of light and a "moving" star will leave a trail on an exposed photographic film. Star trails around Polaris appear as concentric circles (see photo Fig. 1-24). A permanent record of the paths of the circumpolar stars can be made by photographing star trails as described in Project 1-7.

Project 1-8 shows you how to find the center of the star trails. But, isn't Polaris at the center of the star trails? No! Although not discernible, Polaris makes a small circle. You will find its bright arc very close to but not directly at the center. The earth's axis does not point exactly at Polaris. The central point of the circles made by the circumpolar star trails is called the North Celestial Pole (see Fig. 1-6). Imagine the earth's axis extended into space above the North Pole. If this were possible, the earth's axis would meet the sky at the North Celestial Pole.

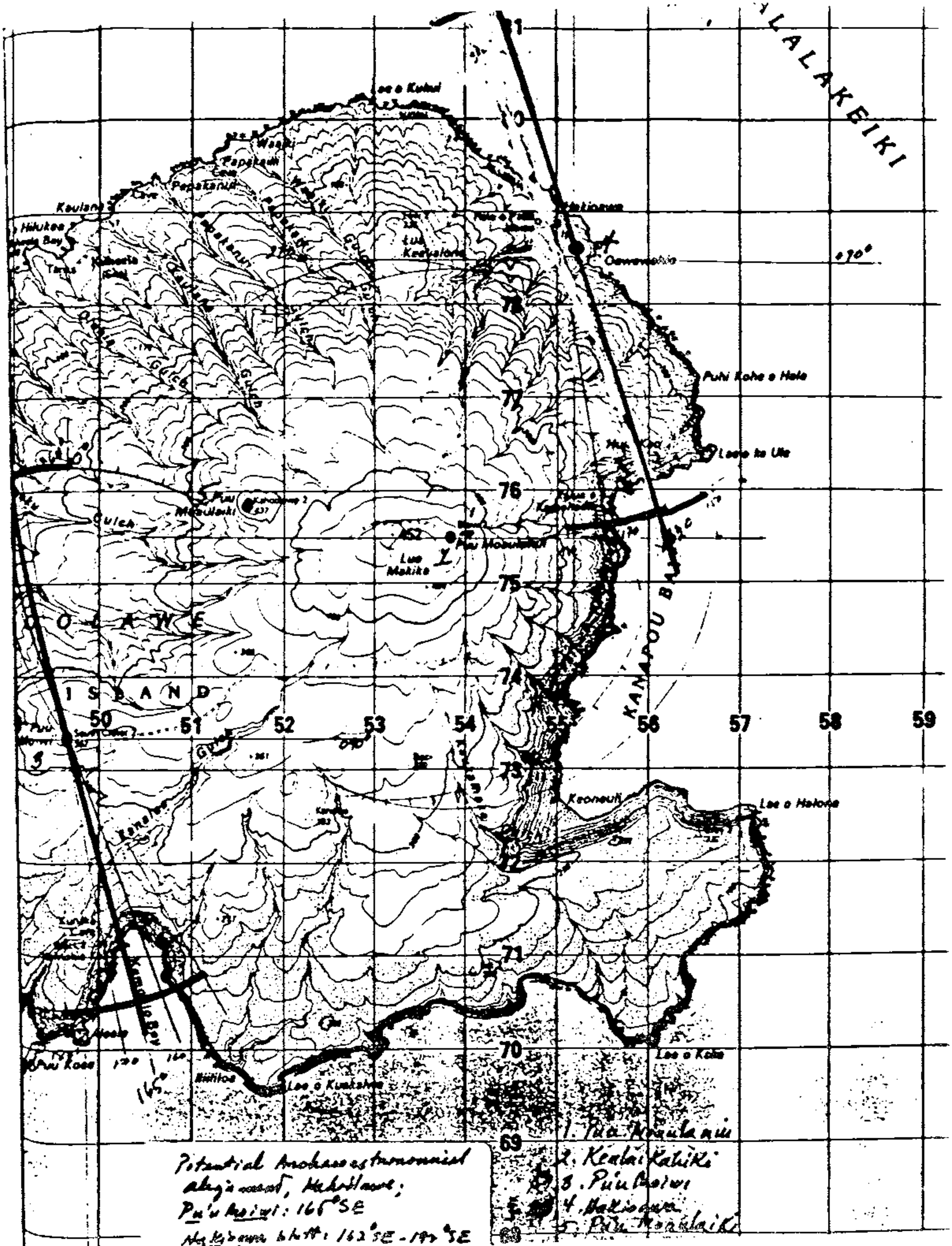
In Project 1-4, Polaris was used to measure your latitude. But your photographs of the star trails show that Polaris is very close to but not precisely at the North Pole. To find your *exact* latitude, you would have to measure the angle between the North Celestial Pole and the north point on your horizon. A navigator at sea or in the air, an astronomer or surveyor must use the North Celestial Pole, not Polaris, to measure his exact latitude.

HOW TO FIND THE BRIGHT STARS OF SPRING

During the spring, the best view of the evening sky is to the south with the Big Dipper overhead. Project 1-9 shows how to locate the bright stars of spring.

THE ECLIPTIC—THE SUN'S APPARENT PATH AMONG THE STARS

Thus far we have examined various ways of locating stars and constellations in the sky. Yet, there are other heavenly bodies within our own galaxy which excite our imagination even more than the stars. These heavenly bodies are *planets*! They are being studied by our deep space probes to Mars and



Potential Archaeoastronomical alignment, Kahoolawe;
Pu'u Moiwi: 165°SE
Hakioawa bluff: 162°SE - 197°SE

[DATA insert]:

(b) The diagrams/charts showing potential archaeoastronomical alignment, Kaho'olawe, were taken by sextant readings on site by Lt. William Klein and by Opti-Compass by A. Pi'ianaia:

(1) Pu'u Mo'iwi [165°SE], from altar stones to rock

(2) Hakioawa ridge to Makali'i [162°SE to Makakilo [172°S], i.e., southern polar stars/constellations, i.e., Canopus, Southern Cross, etc. [acc. Kaho'olawe team, March 1992

Our notes read for Friday, March 20, 1992 VERNAL EQUINOX:

(a) Plan - to visit Moa'ula-nui as highest point of island in order to establish a compass center of references to horizon positions [azimuth] of rising celestial bodies and setting azimuth reciprocal, and:

(b) To relate Moa'ula compass center axis (longitude/latitude/zenith/meridian) to visible island points (as to extremes, i.e., capes, points farthest eas/west);

(c) To obtain from that locus the meridian (kaupoku o ka hale o ke akua [ridgepole of the house of god], or piko o ka honua (local meridian), as to determine stars in the meridian, from 0°N to 180°S from Moa'ula-nui;

(d) To note other rising and setting positions of prominent stars (first/second magnitude) at the equinox (vernal/spring/March)

TEAM: R. Kawena Johnson; Abraham Pi'ianaia, geographer, celestial navigator/naked-eye astronomy/navigation; 'Ilima Pi'i-anaia, international protocol officer for the State of Hawaii; Lt. William Klein, navigation instructor, USN, Pearl Harbor; Rowland Reeve, archaeologist, Kaho'olawe 'Ohana; Captain Milton Roth, Lt. Vern Young.

Lt. William Klein provided his notes for March 20-21, 1992, VERNAL EQUINOX and important stars:

(1) RIGEL in Orion, 34°15', setting at midnight 261°W
(2) BETELGEUSE in Orion, 15° above the horizon, setting at midnight 271°W
(3) DUBHE in The Big Dipper is on meridian 12:00 p.m.
(4) ACRUX (Southern Cross), almost due South at 12:00 p.m.
(5) CANOPUS on meridian, 9:00 p.m.

NAVIGATION WORKBOOK

KAHO ALAWE 20°34'N 156°34W

2Ø THRU 23 MARCH 92

9

20 MARCH 92	20 MARCH 1992			
LAN ☉	LHA	097		
1207	BODY	HC	ZN	
+26				
1233	POLARIS "HOKU PAA"	20 34	000	
	DUBHE	27 32	030	
SUNSET	REGULUS	36 47	090	
1811				
+ 26	PROCYON	65 (RUDE)	138	
1837	"TAULUA"			
	SIRIUS "Ka Hoku Hookele"	53 04	173	
CIVIL TWILIGHT	RIGEL	56 26	215	
1833				
+ 26	ALDEBARAN "KAUKUKUOKAPUAHIKAPUAKAPAUKA"?	63 03	267	
1859 W				
210459?	CAPELLA	60 30	336	
238 55.6	JUPITER "KAAWELA"	26 (RUDE)	092	
14 47.4				
253 43.0	ARCTURUS	—	—	
156 34 OW				
97 0°				
MOON RISE				
2100				

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KAHO'ALAWE

21 MAR AM 20° 34'N - 156° 34 W

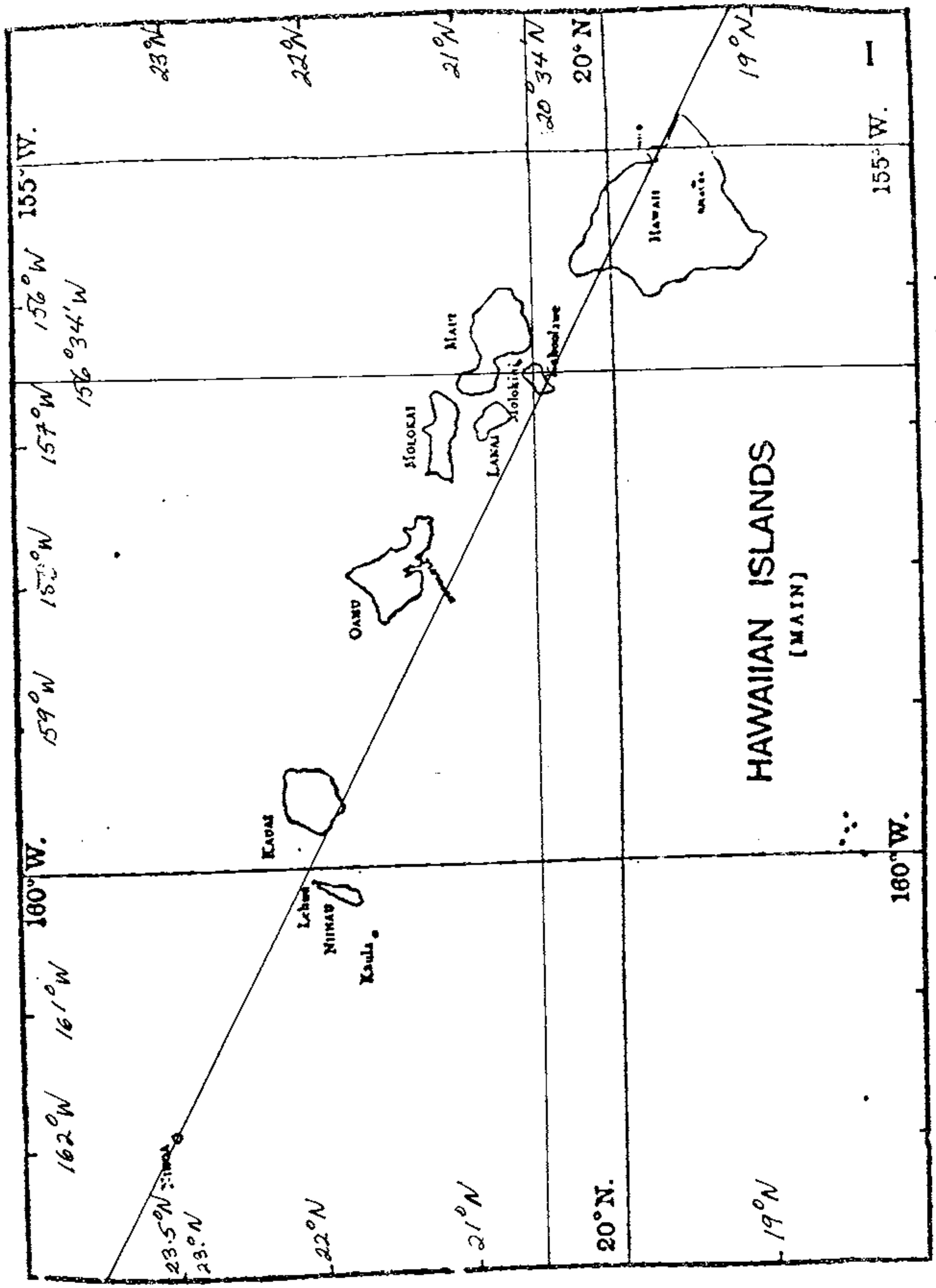
21 MAR	21 MAR	AM		
CIVIL TWILIGHT	BODY	HC	ZN	
0542				
+ 26	POLARIS	20 34	000	
0608.4	"HOKU PAA"			
SUNRISE -	DENEB ◇	48 23	043	
0604				
+ 26	ENIF	35 15	092	
0630.4				
	NUNKI ◇	41 50	163	
LAN				
1207	ANTARES	38 35	206	
26				
1233	ARCTURUS ◇	27 19	279	
211630.4	ALKAID	32 22	317	
59 25.2				
7 37.2	KOCHAB	30 10	347	
67 02.4				
360 427 02.4	VENUS	014	106	
156 34.0	"HOKULOA"			
270 28.4	MARS	22	118	
	"HOKUULA"			
	SATURN	27	128	
	[illegible]			
MOONSET				
0825.6				

NAVIGATOR

KU

9.3
24

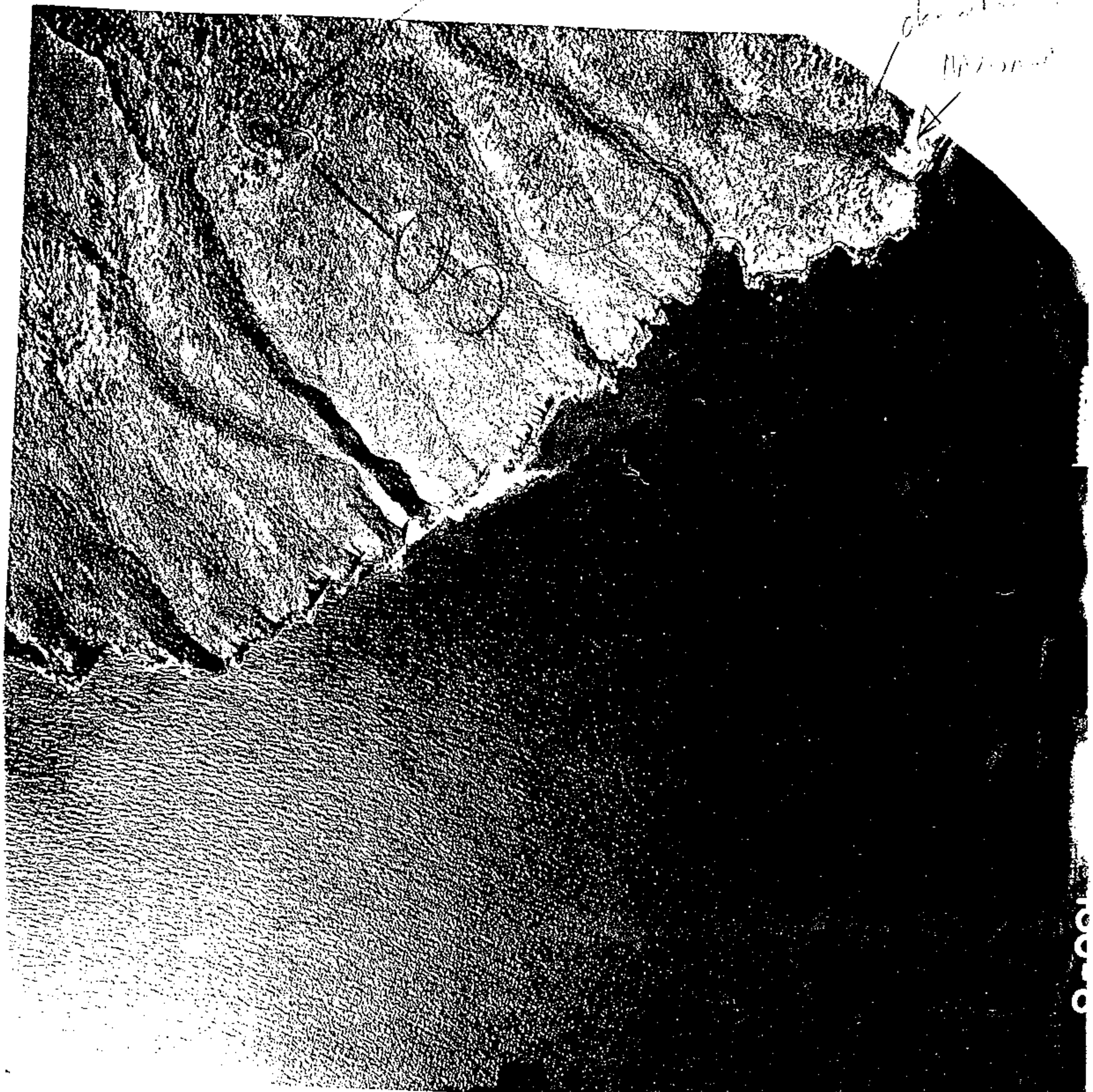
Kaho'olawe: latitude/longitude: <u>Pu'u Moa'ula-nui</u>



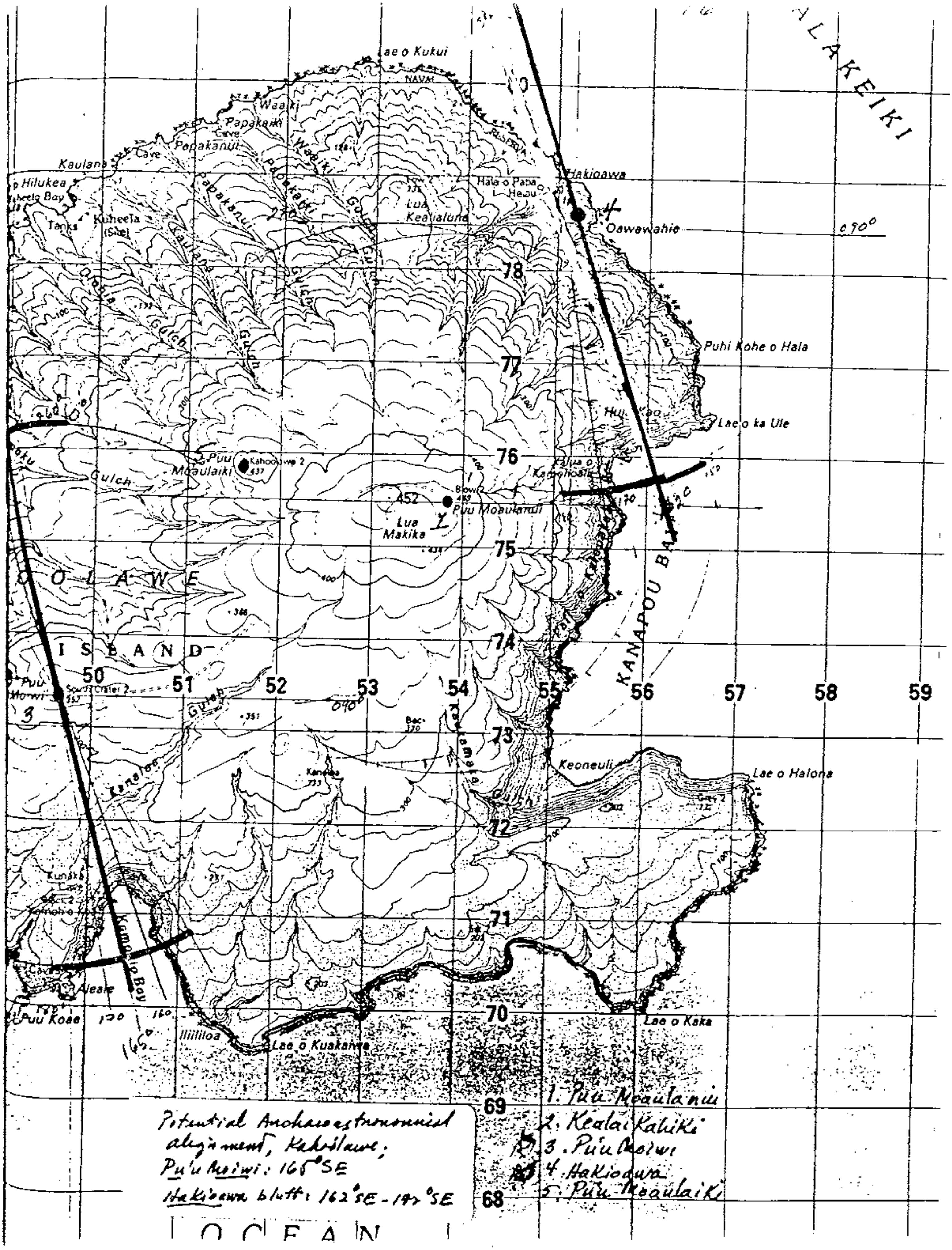
(From Brigham, W.T., 1900: Map 1)

Kaho'olawe: Pu'u Moaulanui
Latitude: 20° 34'N
Longitude: 156° 34'W

Hakioawa Ridge looking southeast March, 1992 Ahu on ridge, upper/lower Photo by William Klein, USN, celestial navigator
Sighted by Abraham Piianaia and William Klein



Topographic aerial photo
Courtesy of Rowland Reeve and Hardy Spoehr
Pu'u Kolekole



Lae o Kukui
NAVAL
Waaiki
Papakaiki
Cave
Papakanui
Kaulana
Hilukea
Kuheeia
Tanks
Hakioawa
Hala o Papa
Heiau
Lua
Kealialuna
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Puhi Kohe o Hala
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Huakao
Lae o ka Ule
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Moaulaiki
Kahoolawe 2
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Kaulua o
Kamohoaliii
Gulch
452
Blow 2
Puu Moaulanui
Lua
Makika
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75
O L A W E
KANAPOU BAY
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I S L A N D
Puu
Moiwi
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56
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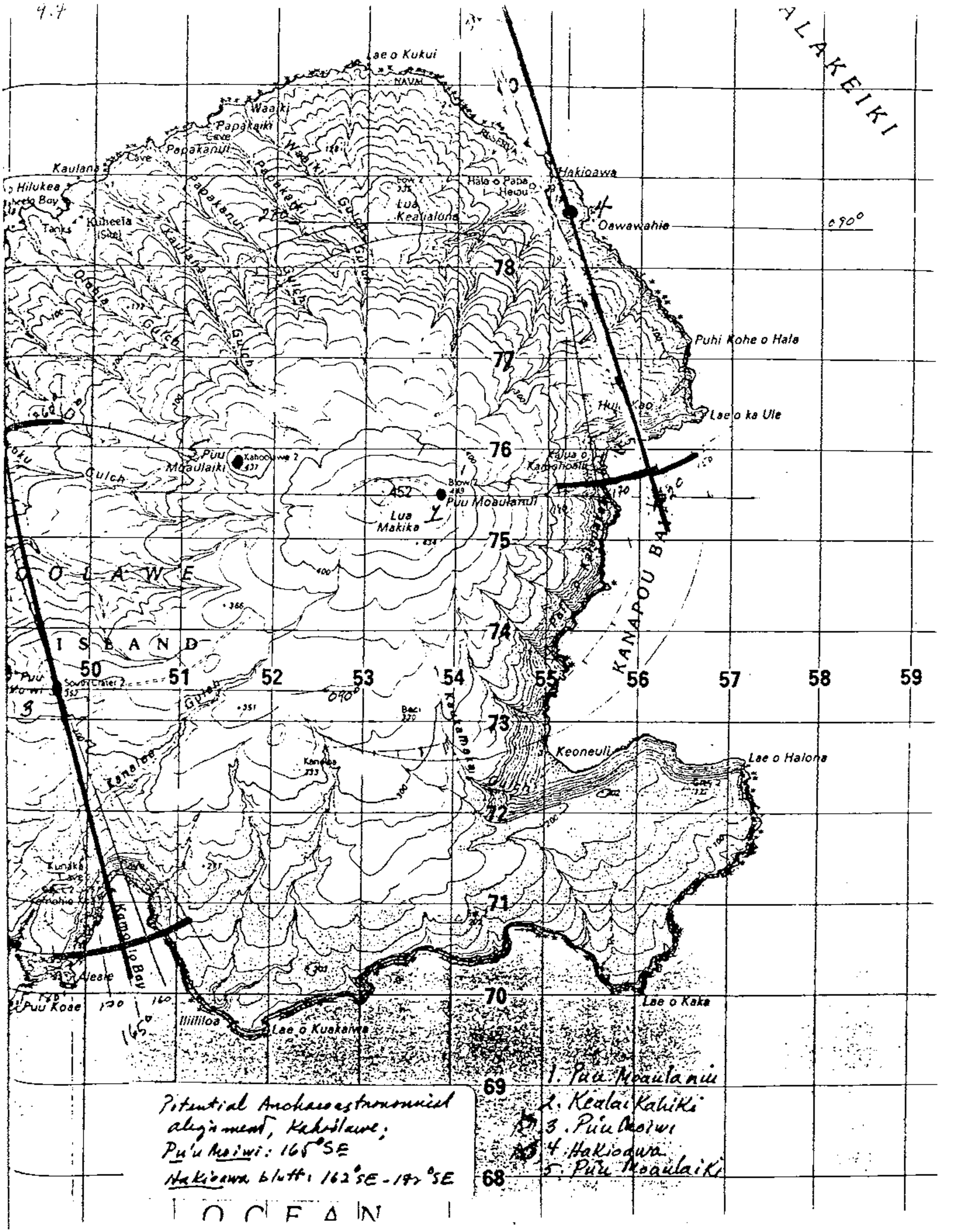
58
59
Gulch
090°
73
Keoneuli
Lae o Halona
72
71
70
Puu Koae
Alealé
Kamohio Bay
Ililiiloa
Lae o Kuakanea
Lae o Kaka
170
160
165°
69
68
OCEAN
ALAKEIKI
1. Pu'u Moaulanui
2. Kealai Kahiki
3. Pu'u Moiwi
4. Hakioawa
5. Pu'u Moaulaiki
Potential Archaeoastronomical alignment, Kaho'olawe;
Pu'u Moiwi: 165°SE
Hakioawa bluff: 162°SE - 147°SE


ALAKEIKI
Lae o Kukui
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Cave
Papakanui
Kaulana
Hilukea
Kuheeia Bay
Tanks
Kuheeia
Hakioawa
Hale o Papa
Heiau
Lua Kealialuna
Oawawahie
090°
Puhi Kohe o Hala
Lae o ka Ule
Papakanui Gulch
Kaulana Gulch
Puu Moaulaiki
Kahoolawe 2
Gulch
Puu Moaulanui
Lua Makika
Kamohio
KANAPOU BAY
O O L A W E
I S L A N D
Puu Moiwi
South Crater 2
Keoneuli
Lae o Halona
Kanaloa
Kunaka Cave
Kamohio Bay
Aleale
Puu Koae
Ililiiloa
Lae o Kuakaiwa
Lae o Kaka
OCEAN
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78 77 76 75 74 73 72 71 70 69 68
165°
1. Puu Moaulanui
2. Kealai Kahiki
3. Puu Moiwi
4. Hakioawa
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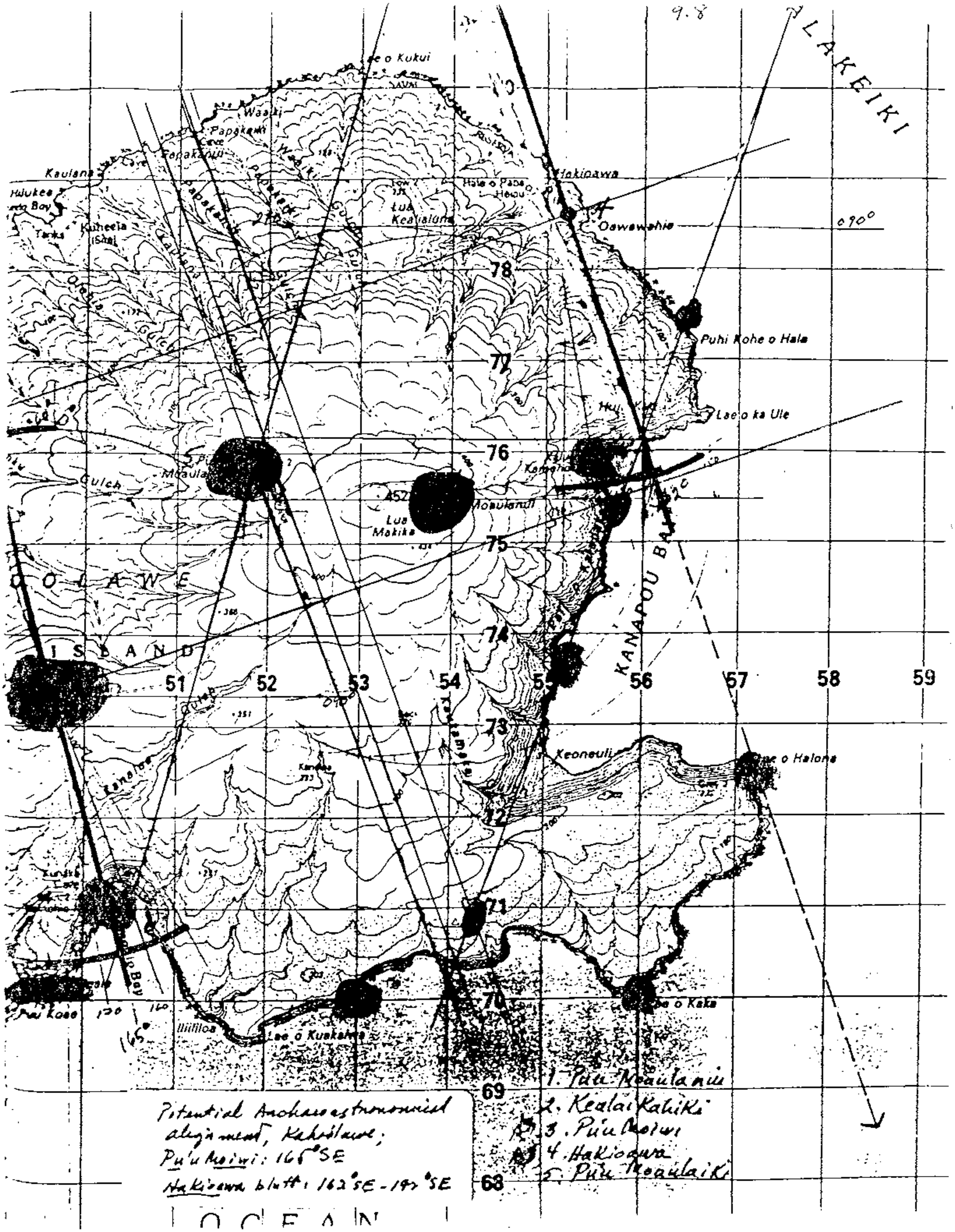
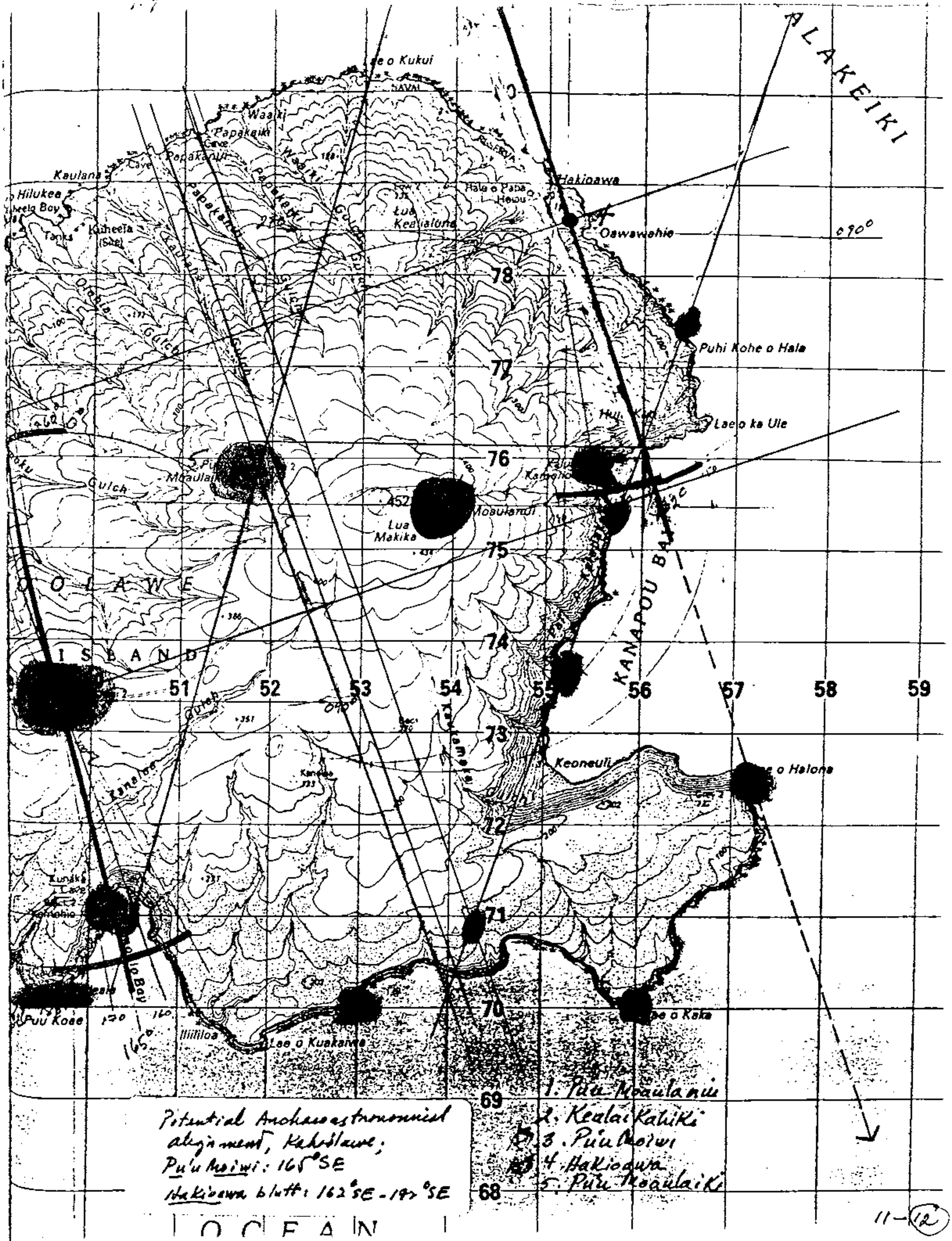


Potential Archaeoastronomical alignment, Kahoolawe;
Pu'u Moiwi: 165°SE
Hakioawa bluff: 162°SE - 192°SE



Lae o Kukui
NAVAL
Waaiki
Papakaiki
Cave
Papakanui
Kaulana
Hilukea
Kuheeia
Tanks
Hakioawa
Hale o Papa Heiau
Lua Kealialuna
Oawawahie
090°
ALAKEIKI
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Puhi Kohe o Hala
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Moaulanui
Lua Makika
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KANAPOU BAY
O L A W E
I S L A N D
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Gulch
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Lae o Halona
Lae o Kaka
Lae o Kuakaiwa
Ililiiloa
Puu Koae
165°
Potential Archaeoastronomical alignment, Kahoolawe;
Pu'u Moiwi: 165°SE
Hakioawa bluff: 162°SE - 192°SE
1. Puu Moaulanui
2. Kealaikahiki
3. Puu Moiwi
4. Hakioawa
5. Puu Moaulaiki

Interpretation:

3:00-4:00 a.m. 3/21/92 VERNAL EQUINOX

Observations recorded:

(1) Rigel in Orion 34°15' setting at midnight 261°W
(2) Betelgeuse on meridian 12:00 p.m. midnight; north
(3) Dubhe in Dipper on meridian 12:00 p.m. midnight;north
(4) Southern Cross 170° almost due south at midnight
(5) Canopus on the quarter toward setting 12:00 midnight
(6) Canopus on meridian at 9:00 p.m. 180°S
(7) Dubhe rising with Southern Cross 6:00 p.m.
(8) Canopus on the quarter east of meridian at 6:00 p.m.
(9) Orion on meridian at 6:00 p.m.

Orion on meridian/6:00 p.m.

* Canopus on quarter
6:00 p.m.

E [S]*Acrux rising/6:00 p.m. W
[N]*Dubhe (Dipper)rising/6:00 p.m.

Canopus on meridian/9:00 p.m.

[S] * Acrux on quarter/
9:00/p.m.

Orion on quarter/
9:00 p.m.

E W

[N] Dubhe on quarter
9:00 p.m.

Acrux on meridian
12:00 midnight

Canopus on quarter
12:00 p.m.

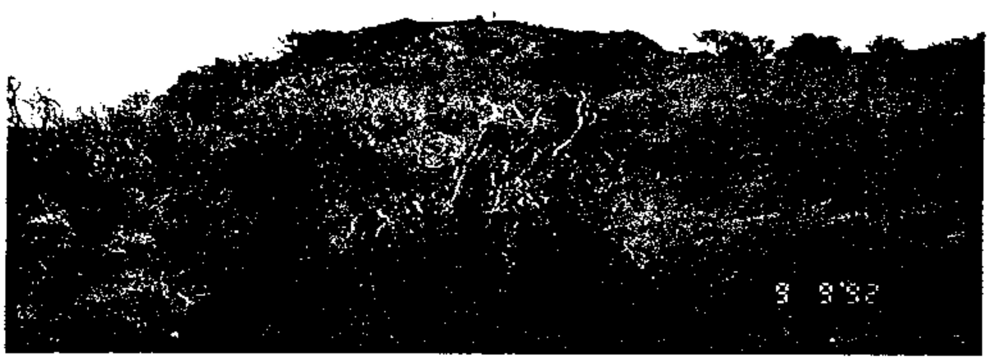
E W

[N] Dubhe on meridian
12:00 midnight

Orion setting
12:00 midnight

Canopus is quarter the distance from the Southern Cross at the pole, or three hours [45°] difference away rising at 6:00 p.m., i.e., Canopus is on the quarter at 6:00 p.m., on the meridian at 9:00 p.m., on the quarter (setting) at midnight [Acrux and Dubhe on meridian north/south], Canopus setting at 6:00 a.m., Orion on meridian 6:00 p.m., on quarter setting to westward at 9:00 p.m. and setting at midnnight.

Aki Sinoto approaching site assumed to be the upper ridge <u>ahu</u>, i.e., "Makakilo".



Aki Sinoto approaching the larger of two <u>ahu</u> stones on the ridge site (as <u>Makakilo</u>)

Makakilo rock, looking toward East Maui.

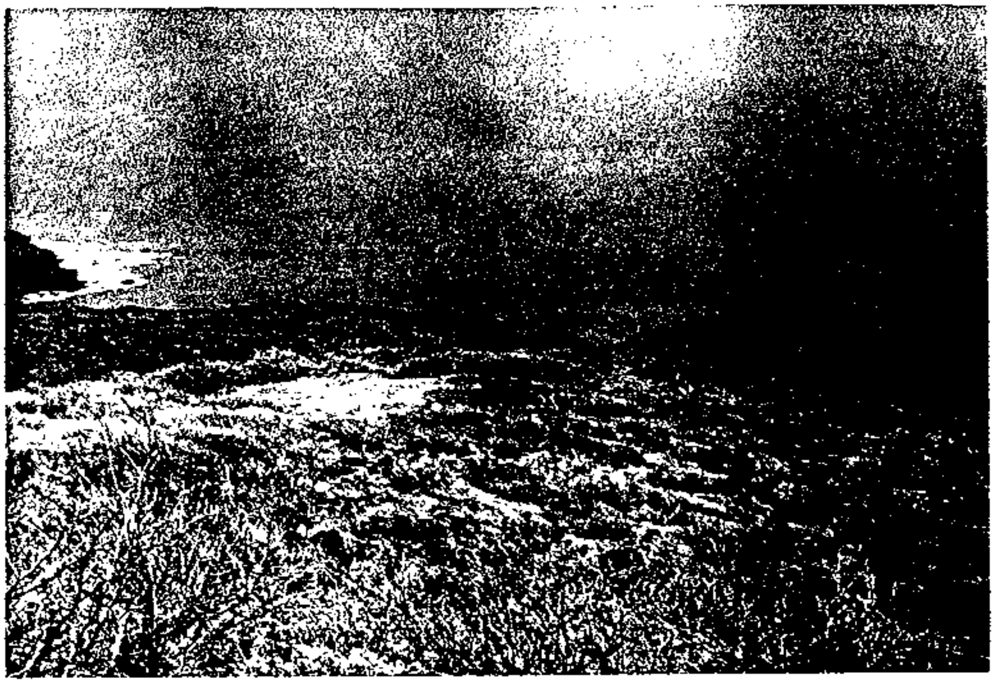
Makakilo site, looking toward West Maui.

Aki Sinoto, standing at the ahu rock, looking across across to Makena, Maui; Molokini Island mid-channel.

Makakilo ahu rock, looking toward Hakioawa, Kaho'olawe.

Clear view of Hakiowa, Kaho'olawe from Makakilo site, toward northwest.

Vern Young at Makakilo site, facing ridges/valleys westward



View down the ridge from Makakilo site to Makali'i site (as projected), at farthest end below.

Ahu rock at Makali'i site, against Hakioawa in the distance. [Photo by Vern Young]

View of Makali'i <u>ahu</u> rock, toward Hakioawa.
[Photo by Vern Young]

View of Makali'i <u>ahu</u> rock, from below.
[Photo by Vern Young]

Aki Sinoto on uphill return climb from Makali'i ahu site [Photo by Vern Young]

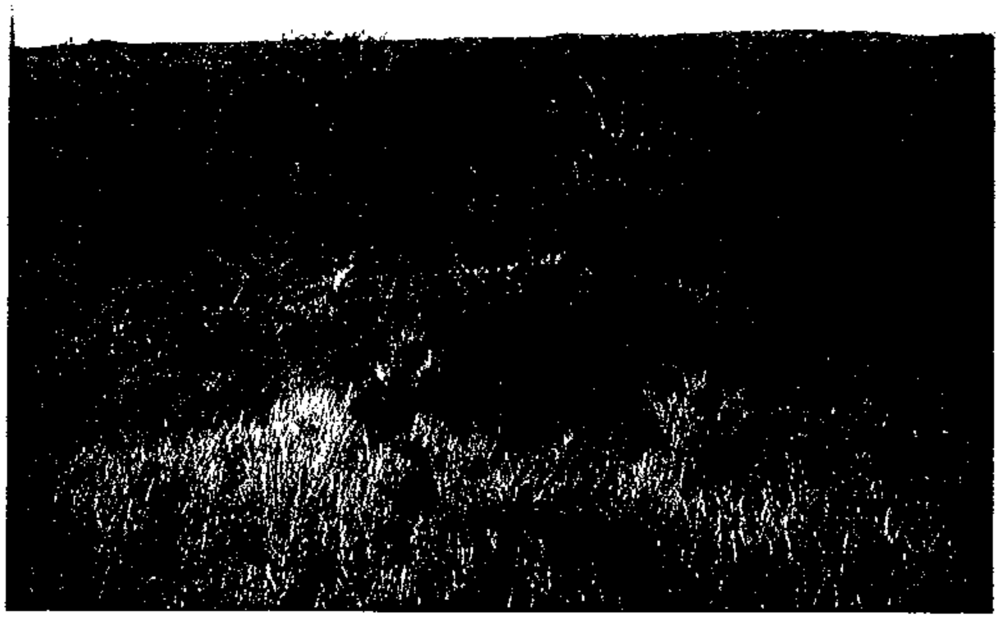
Rock semi-circle, Pu'u Mo'iwi area/Aki Sinoto returned to look around the site.

Small uprights in this semi-circle somewhat analogous to larger uprights in Pu'u Mo'iwi altar ahu.

[*Note: other photos of this sight follow; no archaeo-astronomic consideration at this time].

9.19

9.21



(4) A Probability of Relationship between Sites, Pu'u Mo'iwi to Hakioawa Ridge and the Makali'i/Makakilo Ahu

The Kaho'olawe kaupoku o ka hale o ke akua meridian alignment (north/south axis to circumpolar stars), i.e., the "axle" of the earth's rotation), given similar potential alignments observed at Kukaniloko birth heiau (Central Oahu) and at Ahu a 'Umi heiau (Hualalai, Kona, Hawaii), neither of which has clear view to an uncluttered horizon east/west, but rather, an open corridor between the North Star/Southern Cross (Cassiopeia, Capella in Auriga, and Big/Little Dipper stars, north; Canopus, Fomalhaut, Achernar, south) is apparent from the orientation of Kaho'olawe sites at Pu'u Mo'iwi and Hakioawa Ridge.

A radian measure calculation [acc: Da Silva, Ahu a 'Umi; see Appendix, p.324-325, as to the annual motion of the sun north/south (ecliptic) between solstices/equinoxes (i.e., the tropical year) is:

(a) the angle of the amplitude of the sun, computed from:
(b) the apex (zenith position/locus of the observer at the center of the compass circle) to:
(c) the azimuths (rising points east/setting points west) of the solstice standstill positions (June, summer; December, winter), assuming that:
(d) the bisector of the angle is the equinoctial (March/September) position of the sun between sunrise and noon, so that:
(e) that equinoctial line drawn to the apex zenith of the angle of amplitude is also at noon perpendicular (at right angles, 90^{o}) to a line drawn between north/south at the poles, representing the meridian at noon/midnight, the line between North Star/Southern Cross;
(f) a line drawn between the solstice markers as tangent to the arc of compass horizon circumscribed between the solstice markers is a length = 1/2 the sun's path (ecliptic) = 1/2 the tropic year, the time traveled by the sun between the solsices.

How is this to be coordinated with the length of time it takes the Dipper's stars to rotate? This is another radian measure of time to a different compass circle, and is stated in terms of time per degree of rotation, as:

(1) 1° of circumpolar time is equal to 4 minutes of the earth's rotation on its axis.

Thus:

(a) The rim stars of the "bowl" of the Dipper are Dubhe (alpha) and Megrez (delta), which "pours" or "dips" out the contents. Between Dubhe and Megrez there are 10°. [*Note: these distances stretch out and compress over time].

(b) The stars of the bottom of the Dipper that "hold" water are Merak (beta) and Phecda (gamma). Between Merak and Phecda are 8°.

(c) The stars of the "handle" of the Dipper, or the "tail" of the Bear (Ursa Majoris) are, starting at the connecting star of the rim, Megrez (delta):

(d) From Megrez (delta) to Alioth (epsilon) is 5 and $1/2^{\circ}$;
From Alioth to Mirak (zeta), another 4 and $1/2^{\circ}$;
From Mirak (zeta) to Alkaid (eta) adds another 7°
for a total in the tail/handle of 17°;

(e) The entire length of the rim to the end of the handle is $10^{\circ} + 17^{\circ}$, or 27°; however:

(f) The "Big Dipper Clock" [acc: Greenleaf] cover (bowl + handle) three hour circles = 45° = 3 hours = 180 minutes = 1/8 day.

The length of the whole Bear constellation (Ursa Majoris) containing the Big Dipper is from Muscida (omicron) to Alkaid (eta), equivalent to six hours = 180°, the Dipper equalling about 1/2 that length between Dubhe and Alkaid. To the south, in line with the whole rotation of the Bear are: Alpha and Beta Centaurii, the southern "pointers" to Acrux (Southern Cross) on meridian.

To coordinate the ecliptic time/of the tropical length of [between solstices] the year as 47° = 180 days, a degree of the ecliptic path is approximately $1/4^{\circ}$ ($.25^{\circ}$) per day

As Lt. William Klein's data show for the vernal equinox on Kaho'olawe, when Canopus is on the meridian at 9:00 p.m., the Southern Cross will be on the meridian at 12:00 midnight, in the south, and in the pole, while opposite in the north and in the pole, Dubhe is on the meridian opposite the Southern Cross at midnight. Rigel in Orion is setting south of west at midnight, while ten degrees higher, and 1^{o} north of west, Betelgeuse in Orion is setting at midnight. Where is Canopus at midnight? Setting with the Giant.

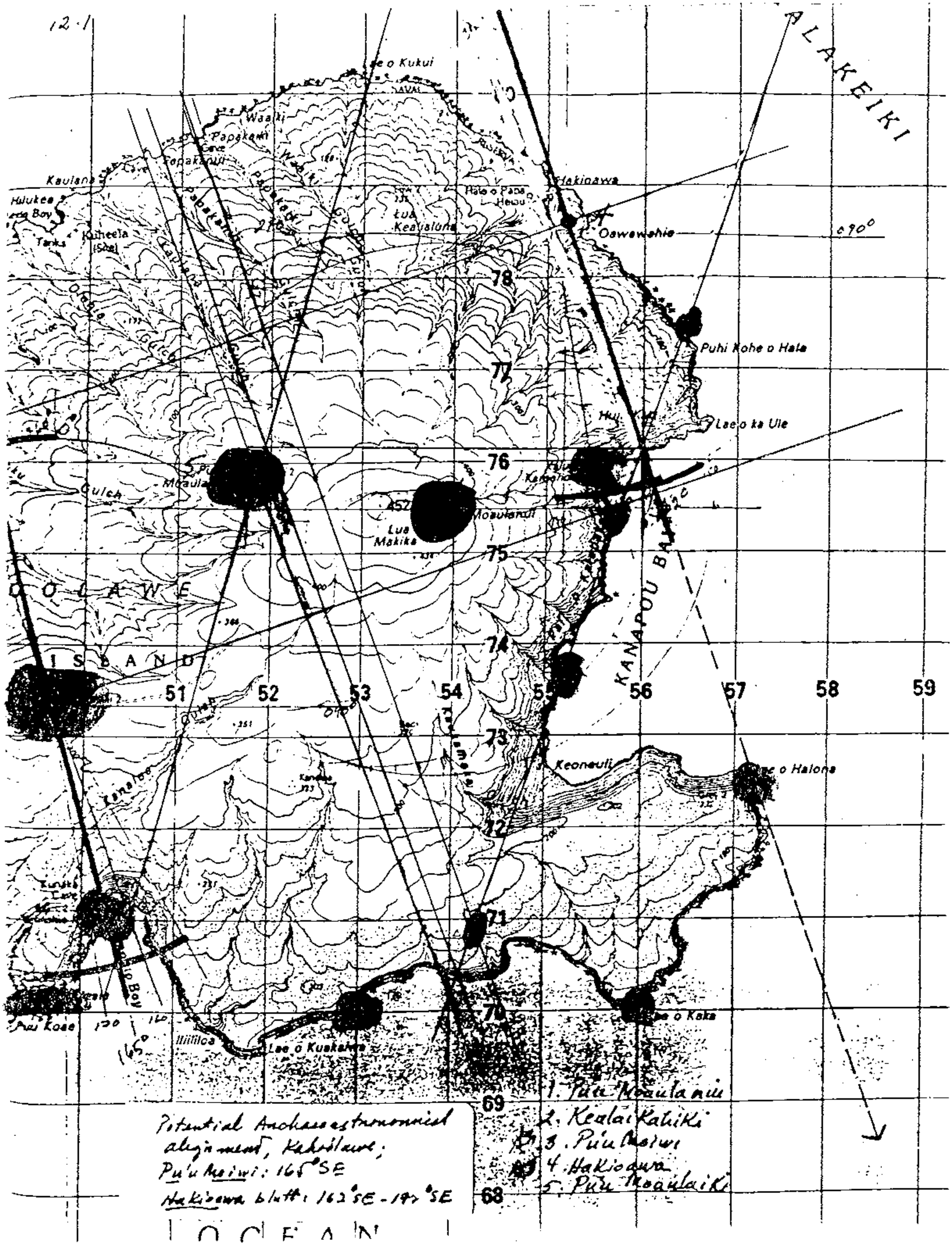
How did the Hawaiian priesthood on Kaho'olawe, as elsewhere, but especially on this island and with respect to potential alignments deduced by sextant/Opti-compass readings of bearings to celestial bodies rising/setting in the direction of ahu markers, natural/man-made at ritual sites, use Kaho'olawe?

From the evidence, as I have suggested, they used the island from Moa'ula-nui as a compass, but that should not be taken to mean that the compass is a place. It is a structural extrapolation of direction based on celestial observation that does not require that the island be there.

Rather, of what significance are the corresponding alignments to other traditional sites on the island, not yet visited but spoken of in reported/recorded tradition, both coastal and inland, and with regard to such sites on other nearby islands? What, specifically, may be said about the ahu pillars, Makali'i and Makakilo, southeast of Hakioawa ridge site marking 162^{o} to 172^{o} of the southern rotation of the pole?

I have colored in the distance between Pu'u Mo'iwi and the Hakioawa sites including the ahu positions (Makali'i/ Makakilo) to show that a discernible pattern repeats itself, so that that distance represents a radian measure calculated to reflect the orientation to the pole to about 15^{o} on either side [165^{o} = 15^{o} away from the pole/ to 15^{o} on the other side = 195^{o}, roughly equivalent to hour-circle segments, reminiscent of the 15^{o} arc = bowl of the Dipper north. The diagram results in what is an analogue to the Aztec Day-Sign glyph [see Johanna Broda, "Astronomy, Cosmovision and Ideology in Pre-Hispanic Meso-America," in Appendix, page 90 of that article].

12.1



KEALAIKAHIKI
Lae o Kukui
Waaiki
Papakanui
Kaulana
Hakioawa
Oawawahie
c90°
Hale o Papa Heiau
Lua Kealialuna
Puhi Kohe o Hale
Lae o ka Ule
Moaulanui
Lua Makika
KANAPOU BAY
Keoneuli
Lae o Halona
Lae o Kaka
Lae o Kuakahua
Gulch
ISLAND
165°
51
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OCEAN
Potential Archaeoastronomical alignment, Kahoolawe;
Pu'u Moiwi: 165°SE
Hakioawa bluff: 162°SE - 147°SE
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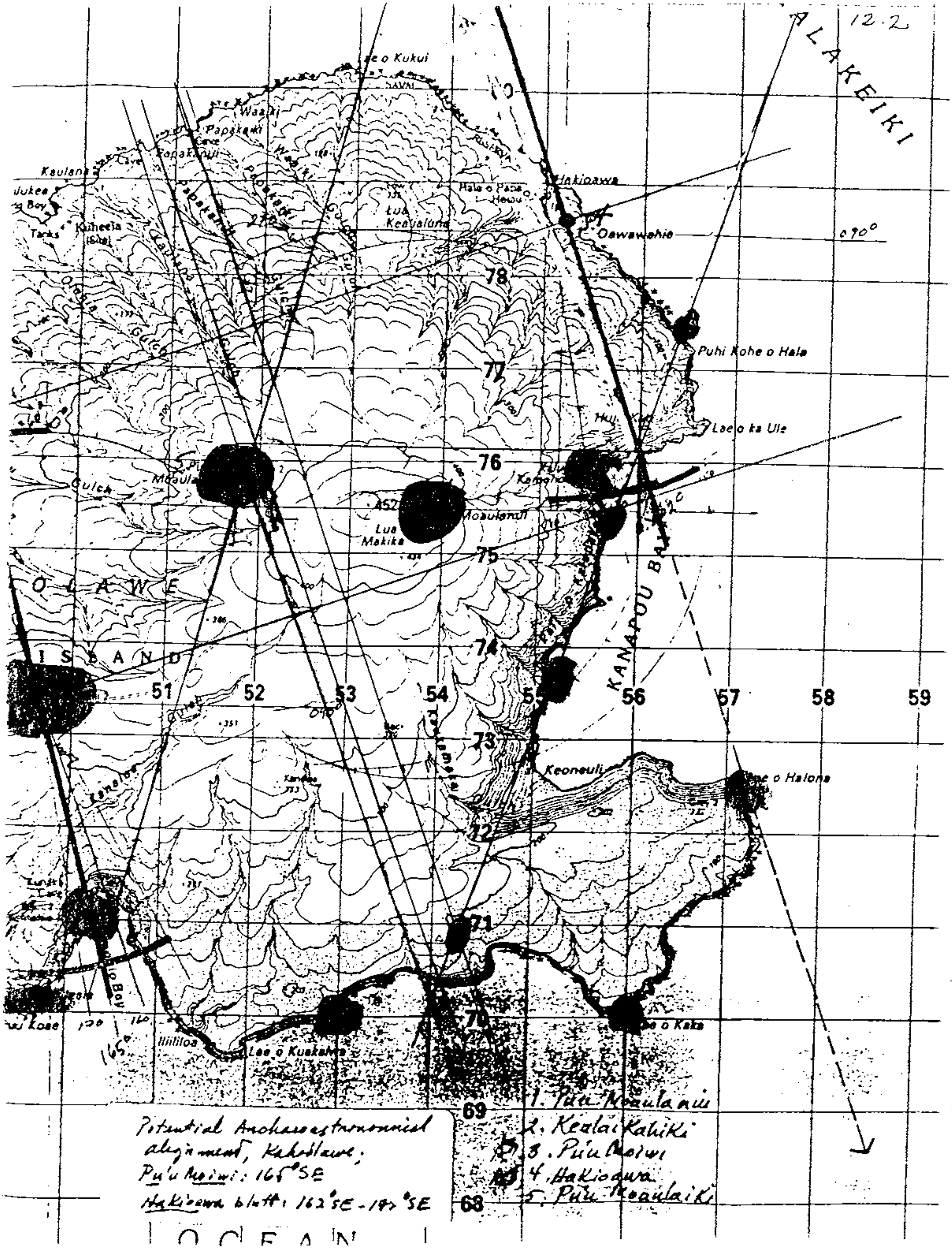
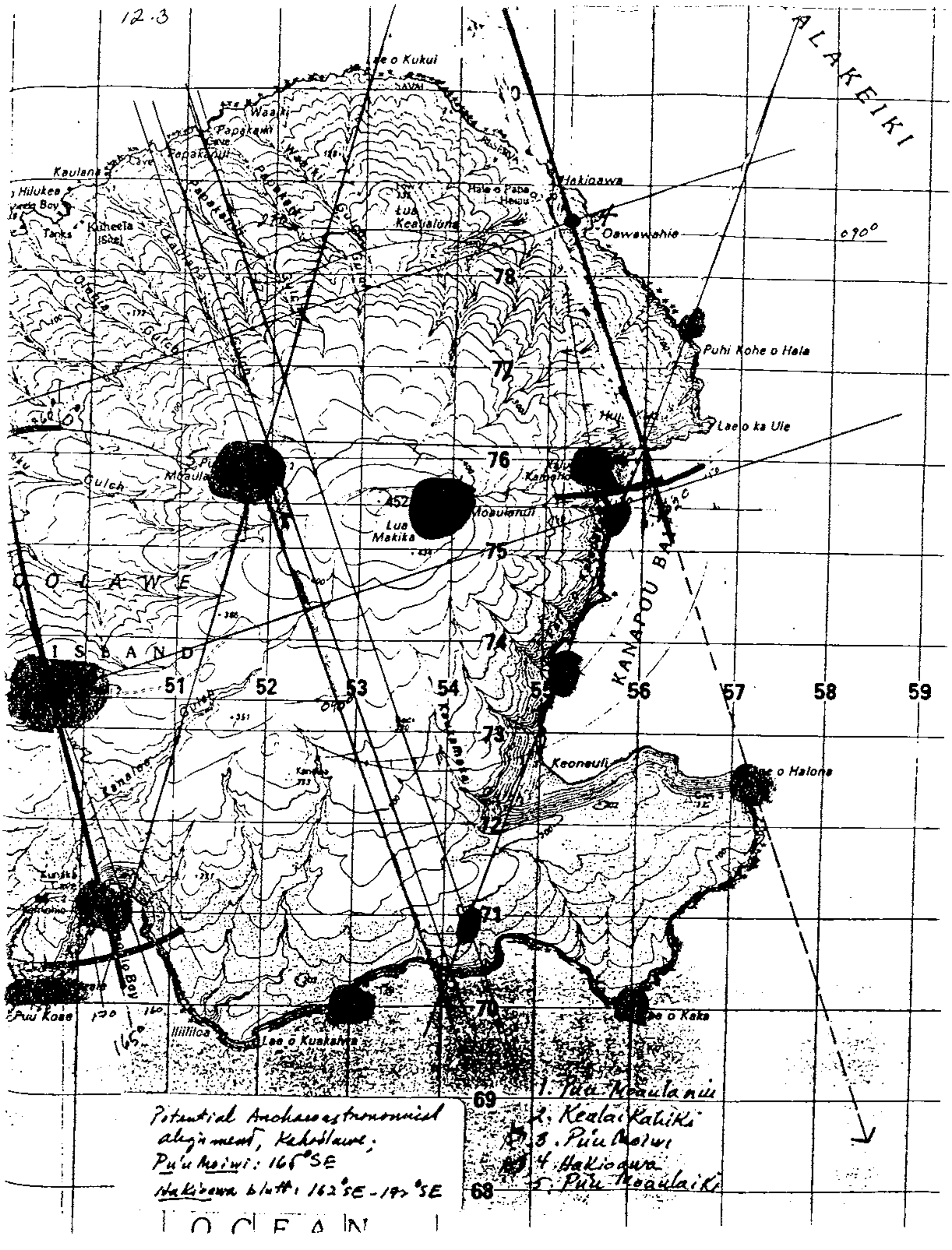
3. Pu'u Moiwi
4. Hakioawa
5. Pu'u Moaulaiki

12.2



Potential Archaeoastronomical alignment, Kahoolawe;
Pu'u Moiwi: 165°SE
Hakioawa bluff: 162°SE - 14?°SE



12.3
Lae o Kukui
Waaiki
Papakaiki
Papakanui
Kaulana
Hilukea
Tanks
Kuheeia
Hakioawa
Hale o Papa
Lua Keaualuna
Oawawahie
090°
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Puhi Kohe o Hala
Lae o ka Ule
Moaulanui
Lua Makika
Moaulaiki
Culch
KANAPOU BAY
Keoneuli
Lae o Halona
Lae o Kaka
Lae o Kuakahua
Puu Koae
Kanaloa
Kamohio
165°
170
160
KAHO'OLAWE ISLAND
ALAKEIKI
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OCEAN
Potential Archaeoastronomical alignment, Kahoolawe;
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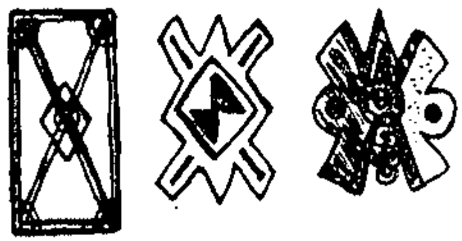


A B C

FIGURE 6. Cosmic diagrams: (A) La Venta, (B) Teotihuacan, and (C) the Aztec day sign *olin*. (From Köhler.[15]).

Tichy points out that, instead, the ancient Mexicans seem to have attributed more importance to the days that divided the year into equal halves, i.e., March 24 and September 20, which account for a division in which the winter half is 8 days shorter than the summer half, than to the equinoxes. To the former date corresponds the angle of 0°57′ deviation E to S, which, according to Tichy, can be found in the axes of the calendrical buildings of Uaxactún and Xochicalco (FIGURES 3, 4).[19]

THE ZENITH PASSAGES

The geographical latitude of Mesoamerica offers one the possibility of observing the two passages of the sun through the zenith in its annual movement between the equator and the Tropic of Cancer (lat. 23°26′ N), the point it reaches on the day of the summer solstice.[20] Between the two zenith passages, the sun moves to the north of the respective latitude of the zenith, an astronomical fact that is reflected in Aztec mythology in the concept that the sun enters the Mictlan, the abode of the dead situated to the north, during *Toxcatl*, the month of the first zenith passage.[21] This observation, which is impossible to make in latitudes north of the tropic, provides the cultures situated between the tropics with certain calendrical advantages, which have not yet been sufficiently explored in all their many dimensions.

The zenith passage of the sun is not only important insofar as the observation of that heavenly body is concerned, but the climatological phenomenon of the rainy season also depends on it, as well. The first passage of the sun through the zenith announces in Mesoamerica that the rains will start soon, which, in turn, is the necessary condition to begin the planting of maize. This interrelationship also found an expression in

myth and ritual in ceremonies related to maize and water. We will return to this point later, since it is fundamental to the understanding of the intimate association that existed between astronomical observation, climatological phenomena, agriculture, and ritual.

On the other hand, the zenith passages were also highly relevant in calendrical terms, since they provide a way to check the correspondence of the calendar and the solar year twice a year. It is easier to observe the zenith than the solstices or equinoxes since, at the latter dates, the sun's position changes only very little from one day to the other, and the difference in its movement is hardly visible.[22]

Observations of the zenith passage could be made in vertical tubes built into pre-Hispanic archaeological complexes like the one in Building P of Monte Alban (FIGURE 7)[23] or the artificial subterranean chimney forming part of the central precinct of Xochicalco.[24] Interestingly enough, the observatory at Xochicalco not only makes it possible to observe the

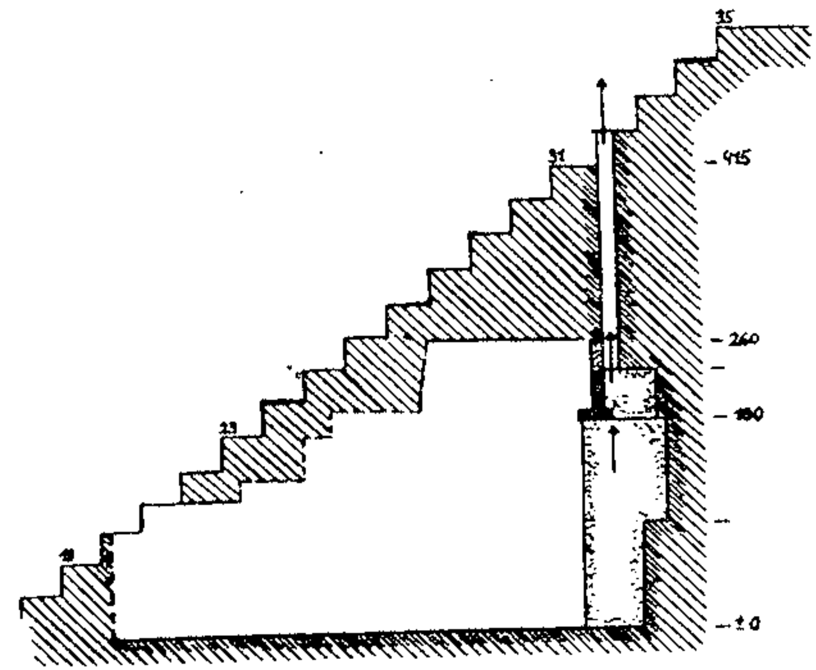
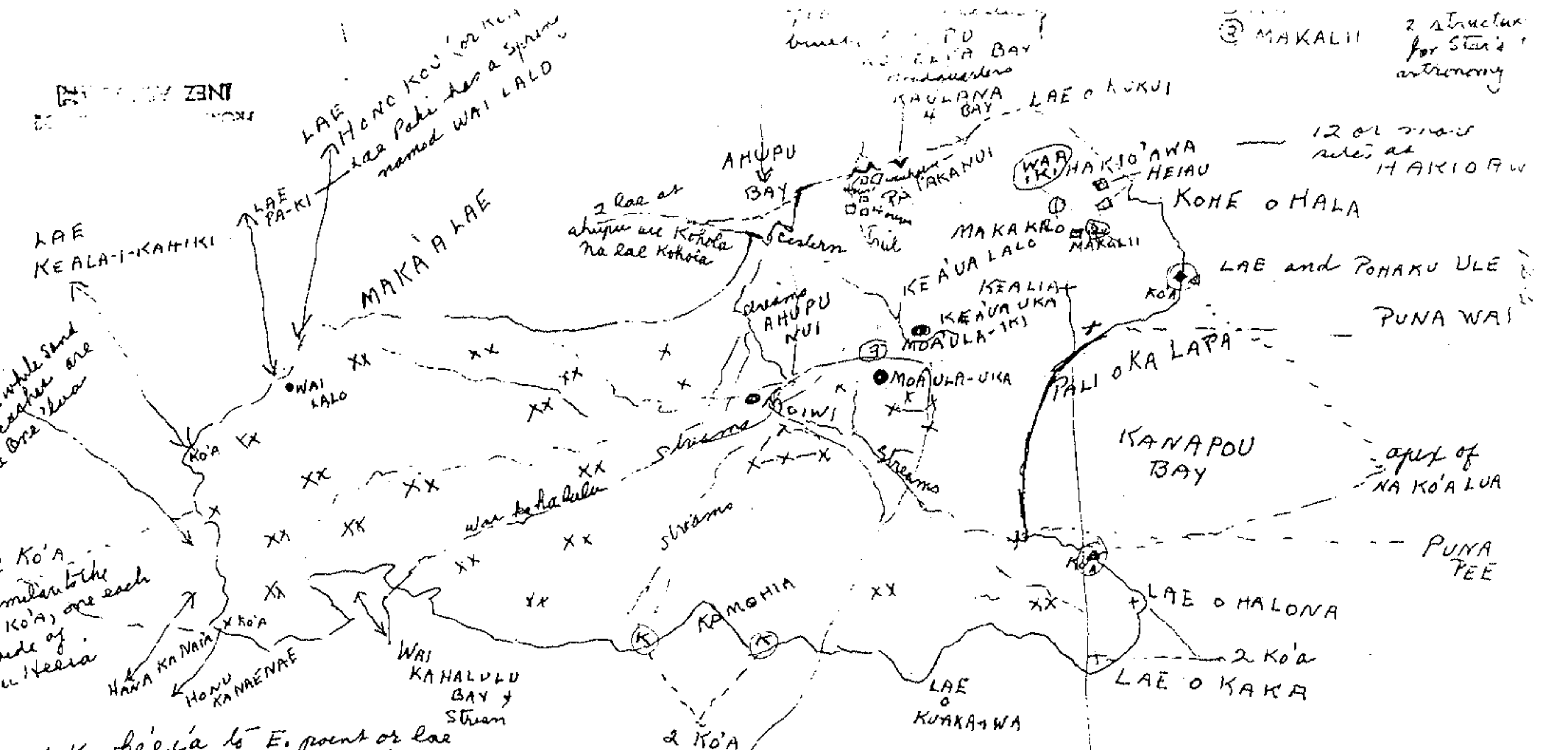


FIGURE 7. The zenith tube at Monte Alban, Building P. (Diagram by Hartung, by permission of the University of Texas Press; see Aveni,[1] *Skywatchers*, figure 85a.)

12.4



at Ku heeia to E. point or lae is Lae Hiluka To west side, Lae Hilu'ula "Sacred Points of east or birth, and west or death

XX - In the xx areas were house sites, sea shells showing purple carried opihi it up.

at Puu Mo'iwi was the big quarry, the "glass" etc.

Should be moo iwi meaning ancestral "bones" or "treasures" - literally, lizard bones

③ PLENTY HOUSE SITES SHELLS etc down to Kamohia side

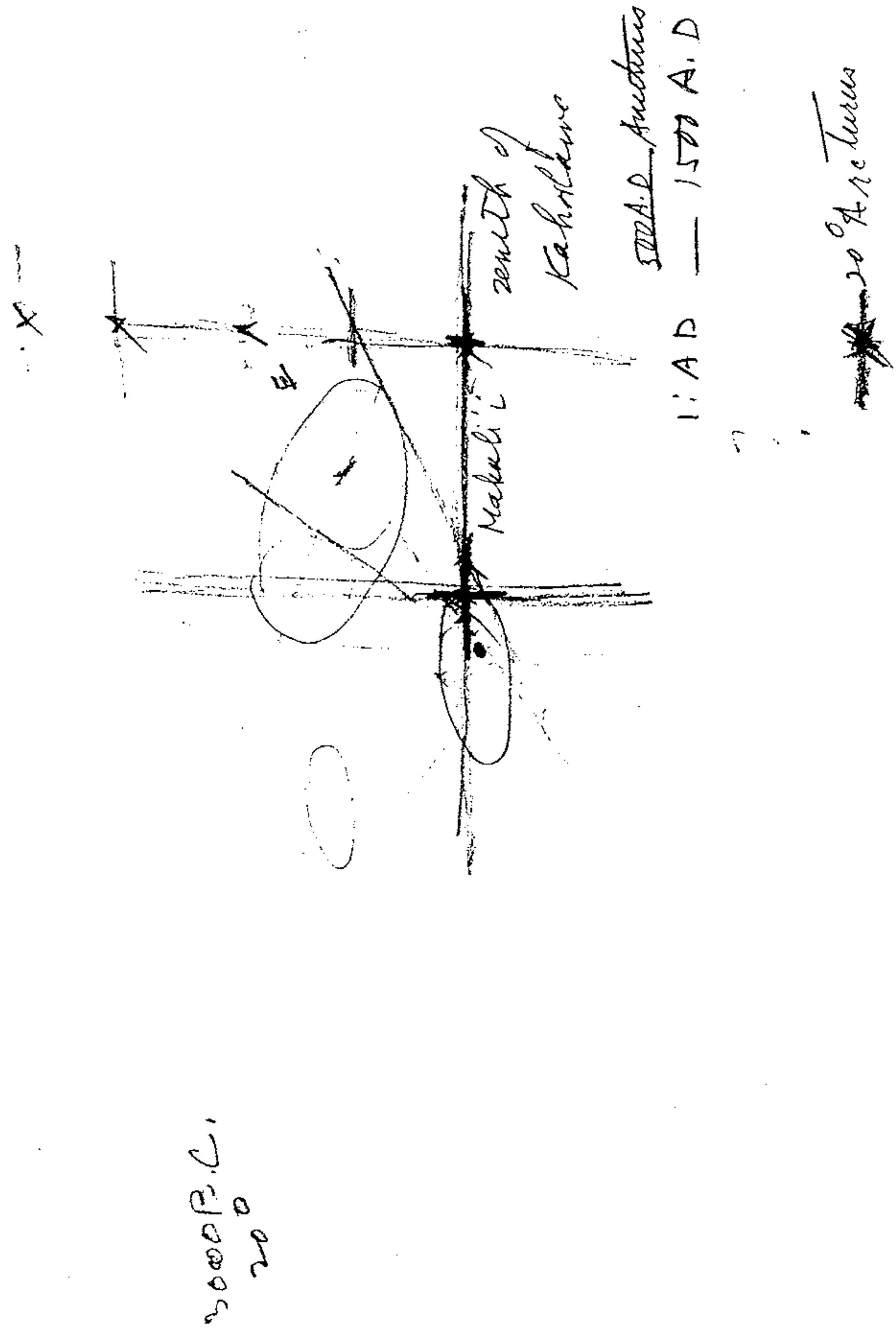
° 4 Kaulana Bay has the stone-paved well

at Hakio'awa was a paved trail, large heiau, 3 smaller "heiau" around Waiaki. Some said wa-'ai ki to mean time eating the traditions
" " wa'a - iki or little canoe

XXX adze quarry was up in here and pieces were scattered about.

Kealia means any swampy place.

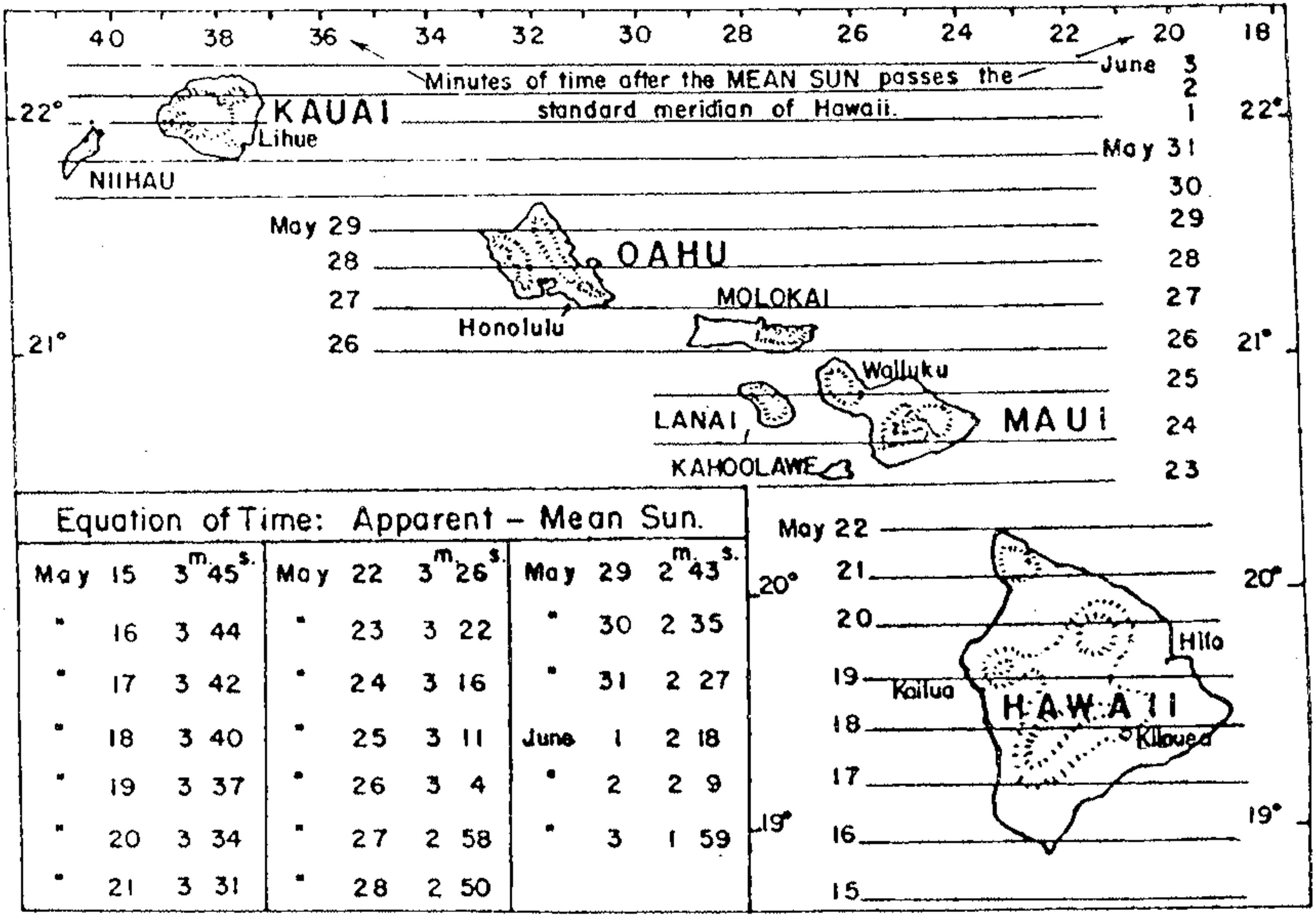
2 "lakes" up here during & after rains streams flowed from these



[Johnson's speculation regarding the Makali'i/Makakilo ahu]

Stars over Hawaii, Bryan, E.H.
Petroglyph press, Hawaii, 1977 p. 41

12.7



Equation of Time: Apparent – Mean Sun.

May	15	3m 45s	May	22	3m 26s	May	29	2m 43s
"	16	3 44	"	23	3 22	"	30	2 35
"	17	3 42	"	24	3 16	"	31	2 27
"	18	3 40	"	25	3 11	June	1	2 18
"	19	3 37	"	26	3 4	"	2	2 9
"	20	3 34	"	27	2 58	"	3	1 59
"	21	3 31	"	28	2 50			

[Insert]:(4.1). The Probable Significance of the Ahu Pillar Stones, as seen from Hakioawa Ridge, i.e., Makakilo and Makali'i

In the tropic latitudes, as at Kaho'olawe, which is at 20°34' (Pu'u Moa'ula), there will be no shadow cast when the sun transits the zenith. This happens twice during the year, and these dates of transit are predictable for any given year by today's nautical almanacs and computer software programs.

Sometime in man's history, about 3000 B.C., some of the world's astronomers calculated that when this happened, the Pleiades (Makali'i) was at anti-zenith, and conversely, when the Pleiades transited the zenith, the sun was at anti-zenith. Upon this ancient knowledge the calendars of Mexico, for example, were calculated and set. Did a corresponding formula determine some of the configurations of ritual stones and naming of observation (kilo hōkū) sites. The question arises as to Kaho'olawe's Makali'i ahu in the range of sight to the polar horizon southeast of Hakioawa ridge, since it is named for the Pleiades. But what is it doing to the southeast when this asterism (in the constellation of Taurus) is to the northeast? To view it properly in the direction of the azimuth of rising of this group of stars in the northeast, the observer must be to the southwest of the Makali'i ahu, where the terrain is not advantageous or practical for celestial observation of the Pleiades. Also, the Makali'i ahu is not a man-made ritually-connected object, looking more like a natural out-crop but very prominent from Hakioawa.

One possible extrapolation, due to its position on the ridge in line east/west from Makakilo ahu, which does have the appearance of a ritual Hawaiian observation site, is the zenith/anti-zenith determination. In addition to the well-known use of the Pleiades to set the calendar at the first new moon after it rose in the east at sunset, in order to calculate the makahiki year from its evening rise in November, the ancients may have known that the Pleiades would move in and out of the vernal equinox, as a result of the precession of equinoxes.

Since the precession is a very difficult motion to observe over 26,000 years, how did the ancients recognize a consistent rate of change of the Pleiades as:

(a) a zenith constellation, and movement out of the zenith
(b) a navigation star on the horizon, and its movement out of the azimuth of rising/setting
(c) the rate at which these changes took place, and how that calculation affects navigation.

For this problem we engaged Dr. Peter Michaud at Bishop Museum's Kilolani Planetarium to furnish the team's report with the zenith position of the Pleiades for the latitude of Hawai'i/Kaho'olawe, from 20°N (where the zenith star is now Arcturus, Hōkūle'a) to 20°34' (the latitude of Kaho'olawe) and also to indicate the rate at which the zenith star for this latitude changes. [See data sheet, appended]. The calendar dates are written in, showing that the Pleiades were the zenith star at the latitude of the Makali'i ahu, Kaho'olawe in 992 A.D., a thousand years B.P. (including Denebola in Leo, that it was replaced by Arcturus 500 years later. The Pleiades were in the zenith of Kaho'olawe and Hawaii between 992 and 1492 A.D., a date which coincides with Columbus in the New World contemporary with the reign of Liloa on Hawaii in 1450 A.D. and Umi-a-Liloa, who built Ahu a 'Umi Heiau about 1500 A.D.

The significance of the Pleiades is discussed by Johanna Broda [see her article in Appendix]. Since the Mexican data would fit Hawaiian data for the same latitude in the Yucatan area, this study is pertinent to observation of the Pleiades and calendrical calculation in the two, otherwise culturally unrelated, areas.

Zenith Stars For Hawai'i

1500 Years Ago-

Scheat - Beta Pegasi - Mag 2.42 — 492 A.D
Alpheratz - Alpha Andromeda - Mag 2.06

1000 Years Ago

Denebola - Beta Leonis - Mag 2.13 — 992 A.D
Pleiades

500 Years Ago

Arcturus - Alpha Bootes - Mag -.04
Hamal - Alpha Arietis - Mag. 2.01 — 1492 A.D.

Now

Zosma - Delta Leonis - Mag. 2.56
Sharatan - Beta Arietis - Mag. 2.63 — 1992 A.D

2000 Years Ago

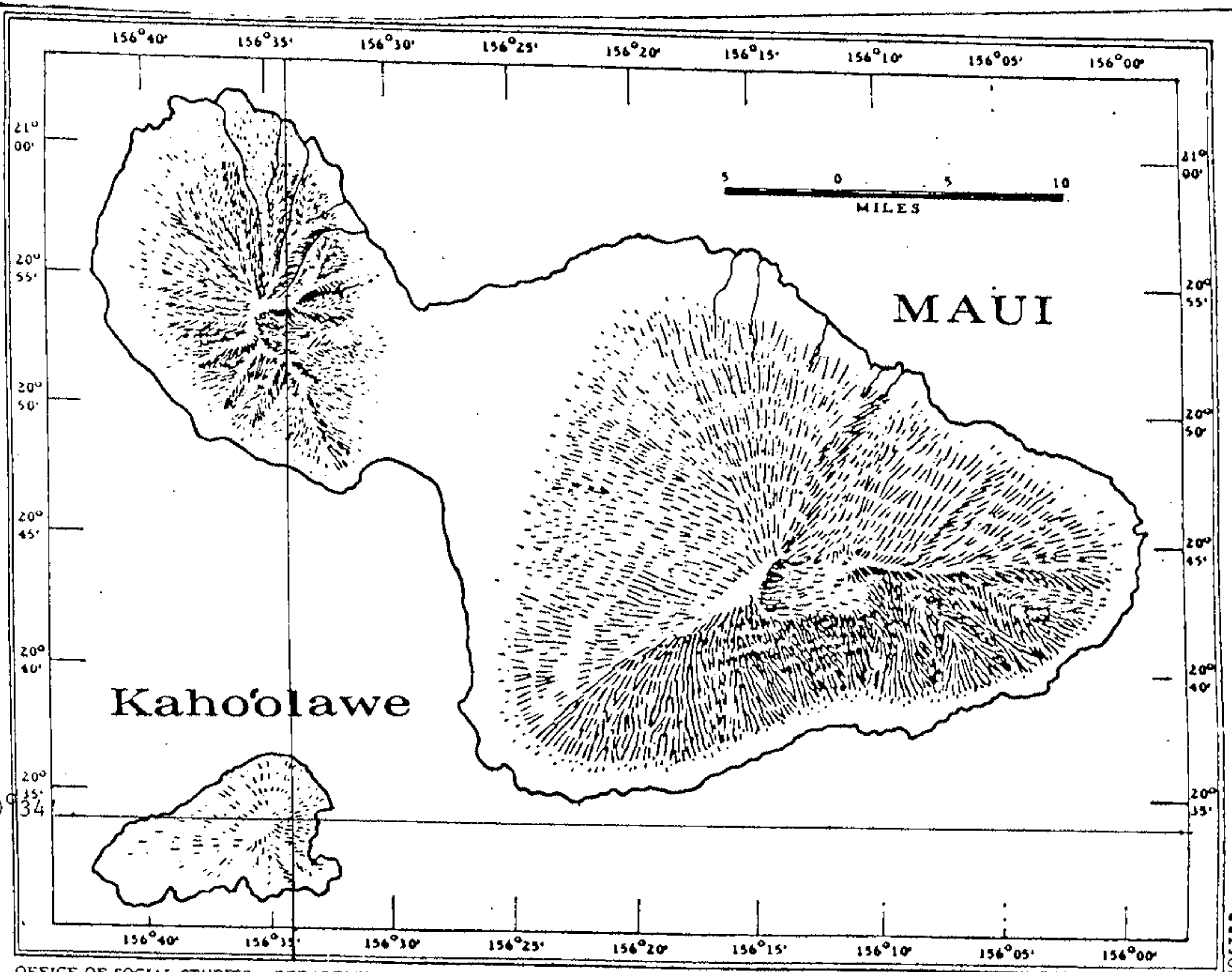
Regulus - Alpha Leonis - Mag. 1.35 — 8 A.D.
Tejat Posterior - Mu Geminorum - Mag. 2.89

[signature]

Dec. 29, 1992

From "Voyager" program

12.11



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*Moa'ula-Nui/Lua Makika, Latitude 20°34'
Longitude 156°34'W

(5) Corroborative evidence from other Hawaiian island sites (West and Central O'ahu):

(a) Moka'ena Heiau, on Kuaokalā Ridge, between Mt. Ka'ala and Ka'ena.

All we have from this heiau is a photograph (in xerox copy), showing how the heiau lines up northwest, using the same kind of bifurcated, or dual rock post in a given direction.

The first view in these zeroxed copies shows the southeast backsight, rather ordinary, and the second view shows the two rocks, with an opening between them, another secondary (possible) foresight rock (hard to see in these) to the point of orientation beyond, i.e., to northwest. [Photograph/zeroxed copy provided by Mr. Joe Singer].

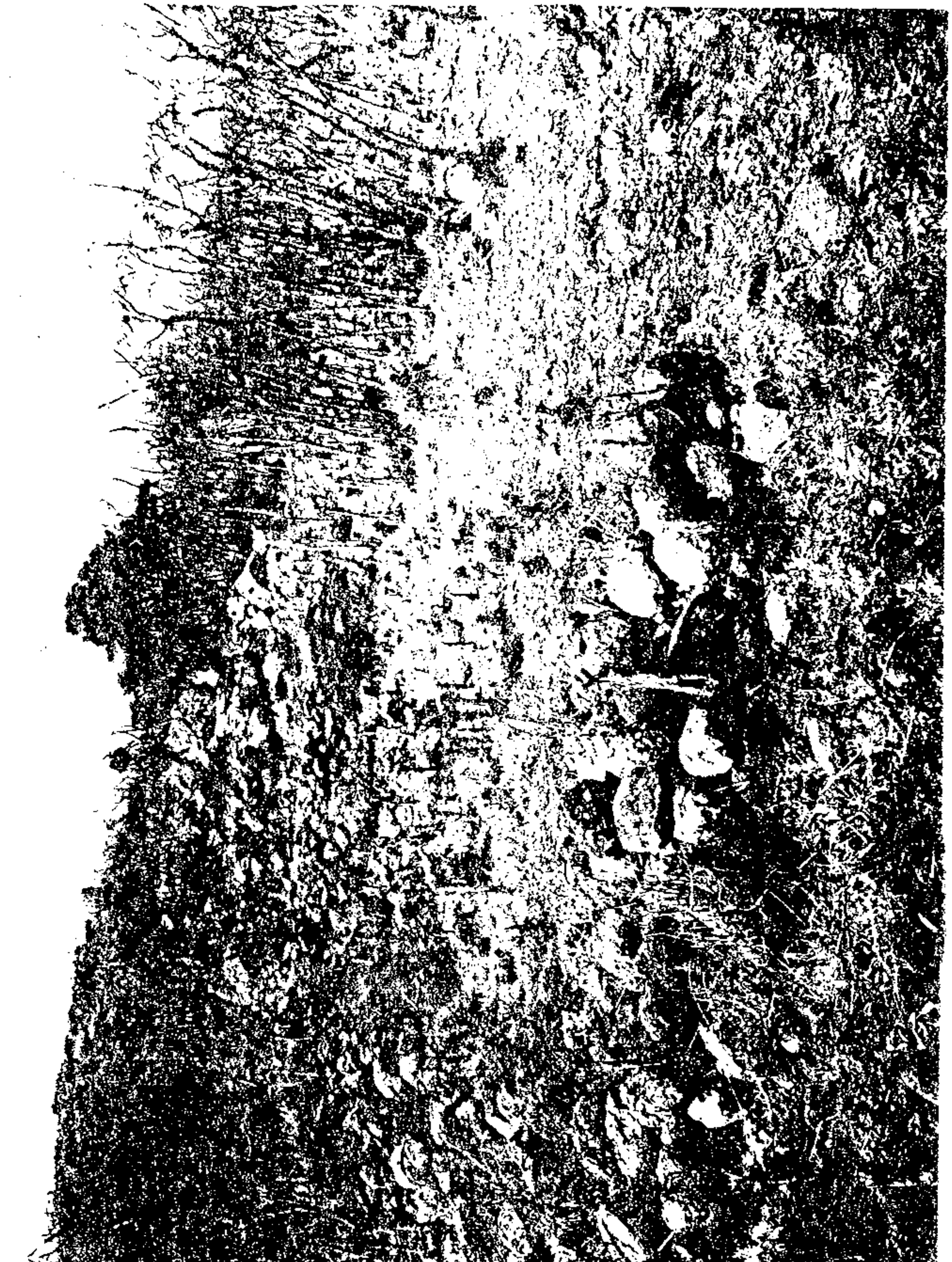
(b) Kukaniloko Birthstones, in Wahiawā (Helemano, opposite Whitmore Village.

The significance of this heiau to what has been thus far discussed re Kaho'olawe sites (Pu'u Mo'iwi, Hakioawa Ridge, Makali'i/Makakilo ahu) is:

(1) the meridian axis north/south
(2) a shaped stone among other recumbent stones, not ahu pillar type, although tradition mentions there was a pillar upright formerly part of the assemblage
(3) a spiral (concentric circles) petroglyph on the shaped stone, which is also made level by either grinding/polishing (or by weathering).

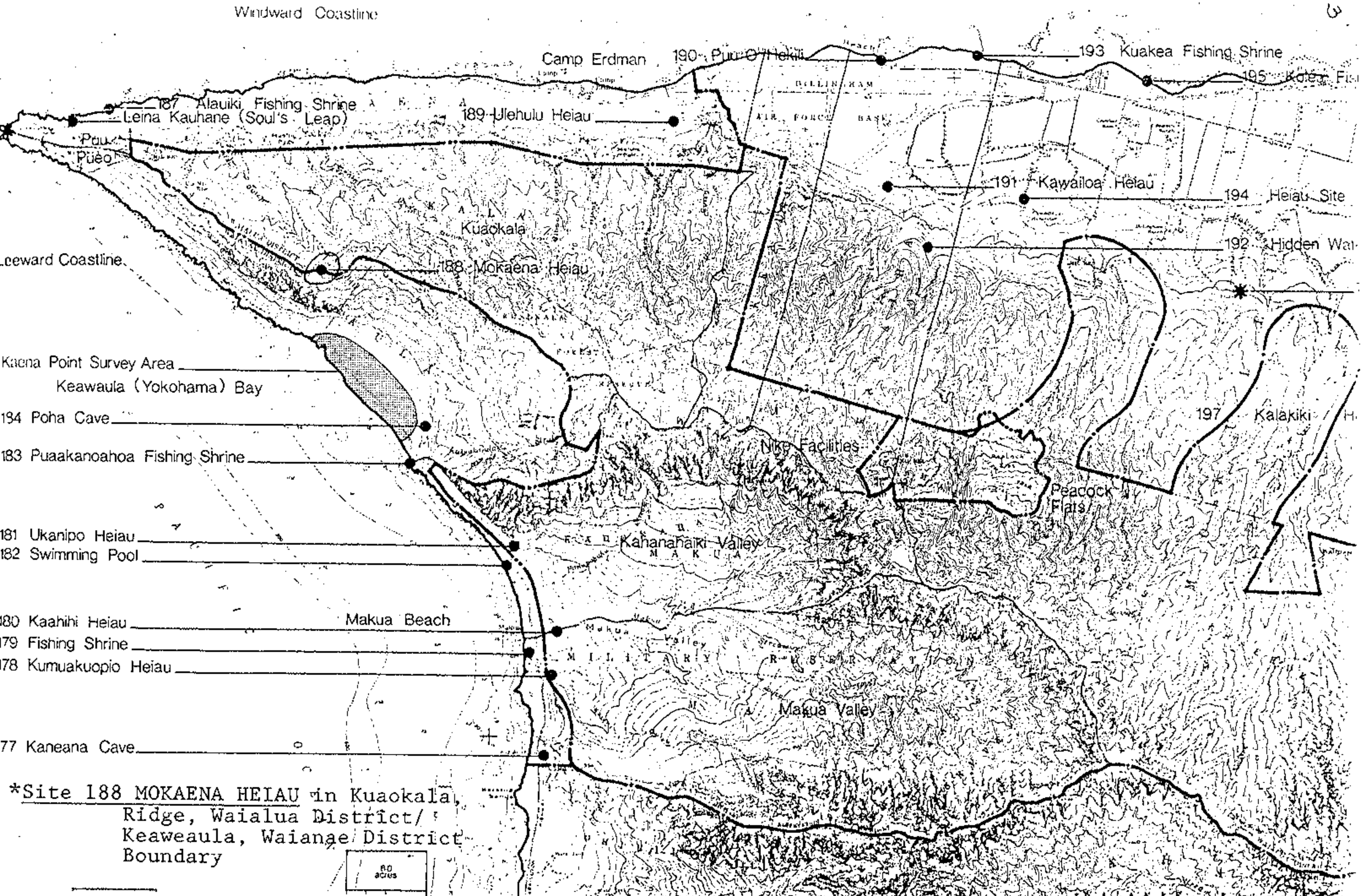
This discussion is presented as the unpublished manuscript by Kurth and Johnson derived from Kurth's studies of alignments to soltice/equinox sunset and, later, to shadow-watching of shadow bisection of the petroglyph at solstice and equinox sunset (quick passage of the shadow dagger across the top of the rock and through the center of the circle, diagonally, and before sunset (slow passage of the shadow dagger through the petroglyph).

13.1



13.2

13.3



*Site 188 MOKAENA HEIAU in Kuaokala Ridge, Waialua District/ Keaweaula, Waianae District Boundary

[Drawing by Kathleen Neumann]

ISLAND OF OAHU

[Unpublished manuscript, 1989]

"The Birthstones of Kukaniloko Heiau: Are They Oriented To Sky Phenomena?"

By Harry G. Kurth and Ruby Kawena Johnson

Out on the high central plain of Helemano in 'Ewa district, O'ahu, stands an isolated cluster of recumbent stones within a circle of eucalyptus and recently planted coconut trees. These are the remains of the birth sanctuary Kukaniloko (Sounds-Within) and its companion heiau (temple) Ho'olonopahu (To-listen-to-drums). At Ho'olonopahu were kept the drums Hawea and 'Opuku, the beating of which heralded births of newborn chiefs at Kukaniloko heiau since the time of Kapawa and Heleipawa about the twelfth century (ca. 1100 A.D.). It is said that each birth had to be witnessed by thirty-six nobles in attendance in order to verify the identity and rank of infants destined to be high chiefs. To have been born at Kukaniloko in those days was a mark of special distinction, and to this day the heiau is regarded as a sacred place.

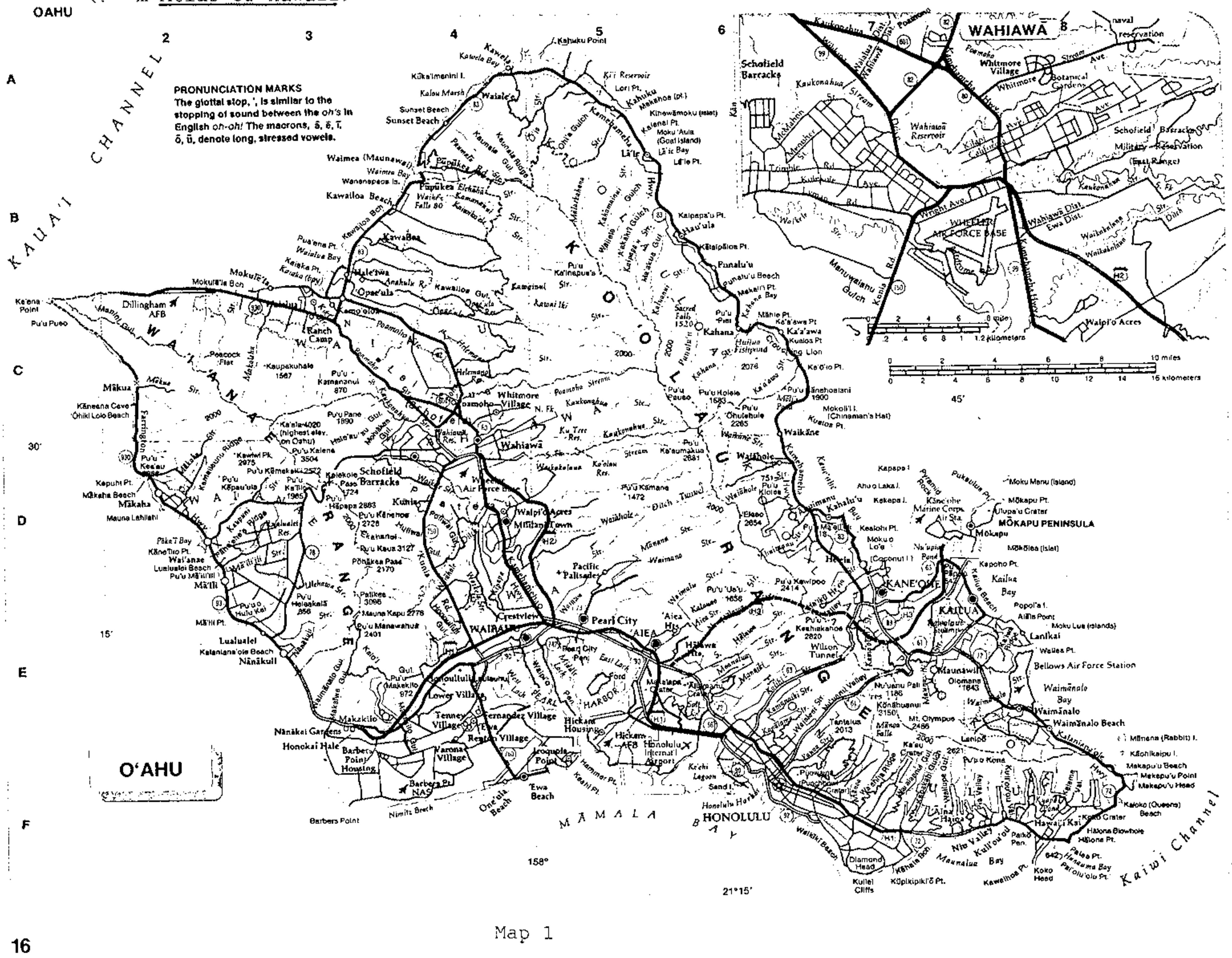
But why here at such a lonely location did the chiefesses feel compelled to go, in accordance with established tradition, to deliver their famous children? And why should thirty-six chiefs be required to ascertain the identities? If the skies here were used to date their births, to what advantage is the heiau's position in mid-central O'ahu?

These are some of the questions that retired U.S. Army Major Harry G. Kurth asked in 1982 when he observed the rays of the sun sinking through Kolekole Pass in the Wai'anae mountain range at winter solstice while standing somewhere within the temple. Looking around at the rocks he discovered one with a diamond shape which reminded him of the Gilbertese "stone boat" formations in Micronesia which are used as star compasses. He began to study the alignment of this particular rock, the stone called in his notes the Kane-Lono rock, and he firmly believed that the stone's orientation and the shape of its perimeter confirmed its probable function as comparable to the Gilbertese star compass. In 1987 while trying to write his interpretation of five years' study of the heiau, building upon an earlier manuscript called "A Hawaiian Stonehenge Discovered," which was circulated in 1982, he was overcome by cancer and died, leaving his notes through his widow, Mildred Kurth, to Kawena Johnson, who has promised to represent his views in this paper and to evaluate his interpretation of the heiau as a "training site" and the Kane-Lono stone as a "Hawaiian sidereal compass stone" (Kurth, 1982:4).

/To readers far away and who have never seen Hawaiian heiau, let alone the Hawaiian Islands themselves, it is necessary to make the place of which we speak here more familiar. Perhaps photographs and charts suffice to help us all reach that objective. O'ahu, for those who know Hawaii not, is the island where the capital city Honolulu is located (See Map 1)/.

It was first necessary for the investigator to develop a procedure, a methodology, to achieve the desired evidence for the interpretation that the heiau location was ideal for observing the ecliptic, but to apply that to the Kane-Lono stone to effect a convincing geometry for celestial alignment was more complicated. In evaluating Kurth's procedure, we notice the following steps which he took to acquire measurable data:

(f m Atlas of Hawaii):



Map 1

1. Observe the alignment of the diamond Kane-Lono rock in Kukaniloko Heiau to these axes:

   a. Winter solstice sunset to Wai'anae mountain range (Winter solstice sunrise to the east is difficult because the Ko'olau mountain range is usually under heavy clouds)

   b. Vernal equinox/autumn equinox sunsets; measurement of length and direction of shadows at meridian

   c. Summer solstice sunset to Wai'anae mountain range

2. Ley lines from petroglyph spiral circles and cup-marks on Kane-Lono rock and adjacent rocks with extensions along compass and course directions from O'ahu to other Pacific landfalls

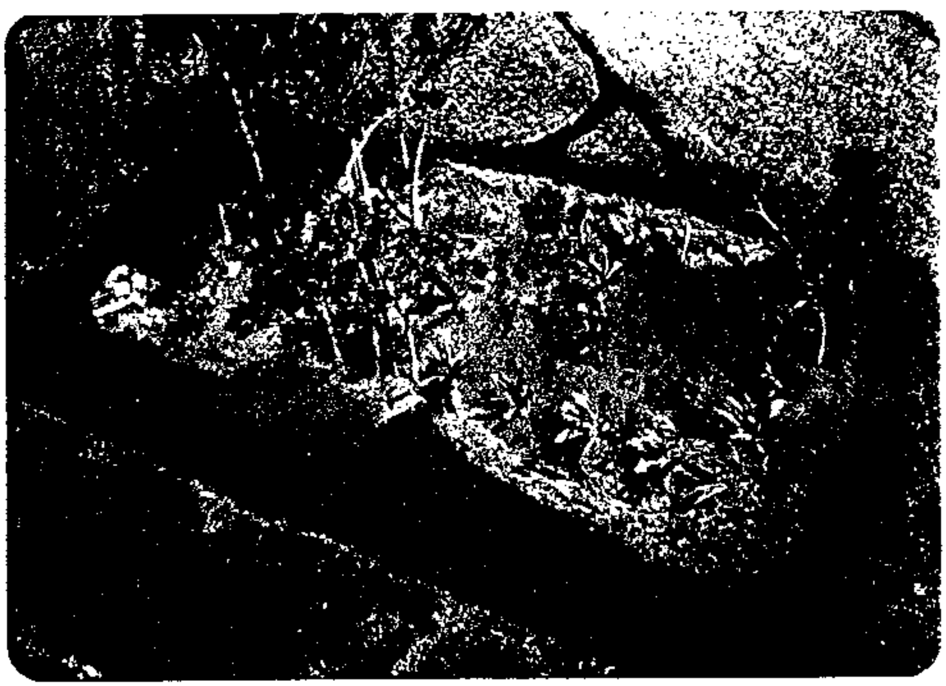
3. Alignment of the Kane-Lono rock to other prominent landmarks and to heiau sites on or close to the parallel of latitude, i.e., Kane'ilio Heiau westward, to Pu'u Ka'ilio in the Wai'anae Range; alignment to other recumbent rocks in the heiau itself.

4. Plot out the positions of rocks and number them from an aerial, overhead perspective.

(In the last procedural step Kurth secured help from the military and funding from the Daughters of Hawaii to get equipment and personnel to help with photographing and measurement).

In the following photographic illustrations (Ill. 1 and 2), the views from east to west (Wai'anae Range) and an aerial view of the heiau (southeast to northwest), the heiau presents that forlorn appearance of isolation against Kolekole Pass with most of Mt. Ka'ala to the northwest end of the Wai'anaes under clouds, while from within the aerial view one notes that the stones exhibit no structural pattern of perceptible geometric character. There are boulders strewn about almost as though they were left in the positions in which they were originally found. It is not known whether they were brought there from another place, while some reports mention that they are stratum rocks and not loose boulders.

Illustration 1. View from east to west at Whitmore Village intersection; indentation in Wai'anae Range is Kolekole Pass; eucalyptus trees at Kukaniloko.



Ill. 2. Aerial view of Kukaniloko birth stones. View from southeast to northwest.

Spurred on by the winter solstice sunset sighting through Kukaniloko heiau that eventful December of 1982, Kurth began to study the heiau with reference to the sun's motion along the ecliptic as seen from mid-central O'ahu and at that parallel of latitude, about N 21° 30', and about 158° west longitude.

Ill. 3. View toward Kolekole Pass from Kukaniloko

Ill. 4. Winter solstice sunset, from Kukaniloko, December 1985

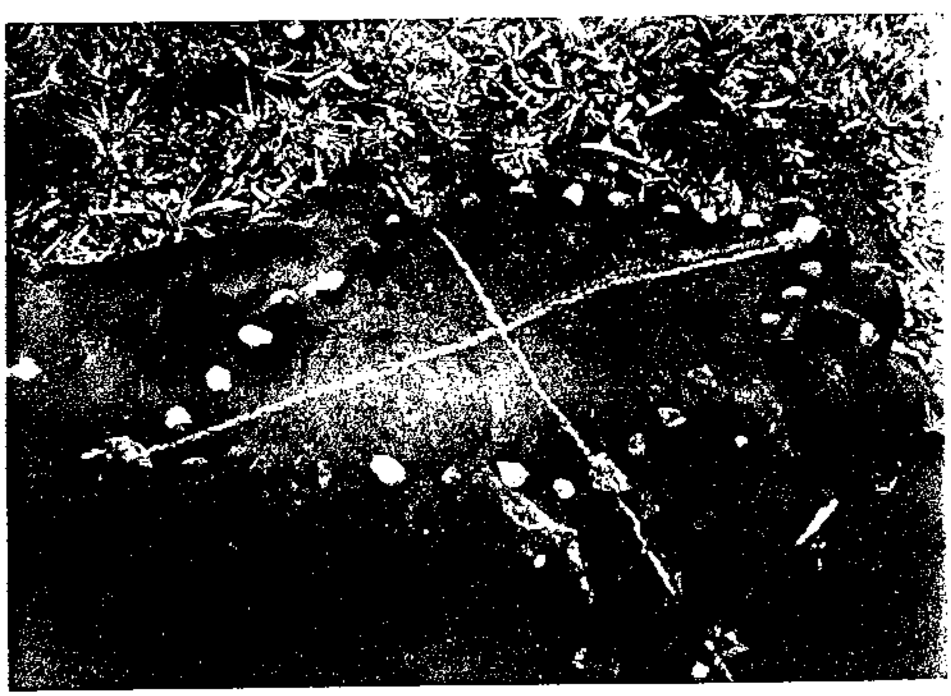
Ill. 6. View from southeast to northwest, from Kukaniloko to base of Wai'anae Range at Mokuleia

Ill. 7. Summer solstice sunset, June 1986 over Mokuleia

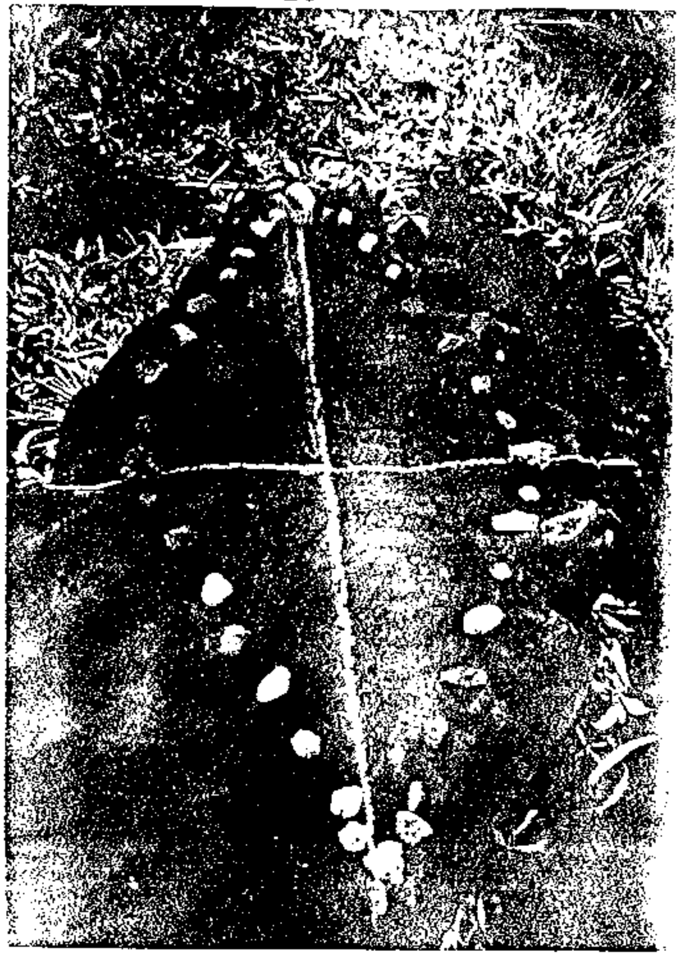
Focusing his attention on the Kane-Lono stone, Kurth took compass readings from the stone's surface but gave no readings (Ill. 8, 9, 10), although from notes left on the backs of the photos one surmises that he was interpreting worn serrations on the rock's perimeter as though they were compass degrees around a circle:

Ill. 8. The Kane-Lono diamond-shaped rock
Ill. 9. (Below)

Ill. 10. Kane-Lono rock, looking from south to north.



Ill. 11. Applying the principle of the Gilbertese 36 ten-day pebble intervals and points to the diamond.



Ill. 12. Sighting along the diamond from north to south.

To fully appreciate this approach or the justification for its application, it is necessary on one hand to consult his figures of the Gilbertese diamond "stone boat" configuration of the sidereal compass stone formations, and on the other, to know that the Hawaiians counted the progress of the sun along the ecliptic between the solstice extremes from south to north in ten-day week intervals. This gave the diamond a 180-day period for the north to south half, or half a year, and the progress back to the northern solstice another 180 days, allowing about 5 days for the 365-day solar, or tropical year. For this paper the figures Kurth drew from other publications on page 4 of his 1982 manuscript are excerpted as his attempt at proof of possible comparability to Gilbertese stone boats.

fig. I- Hawaiian Sidereal Compass Stone
("Stone Canoe")
located on left center between "birthing stones" #I2 and #I5
Photo taken from NE direction

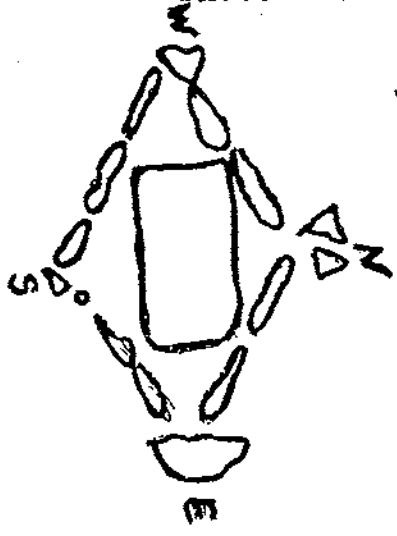


fig. 2-Gilbert Islands version
of Marianas sidereal compass

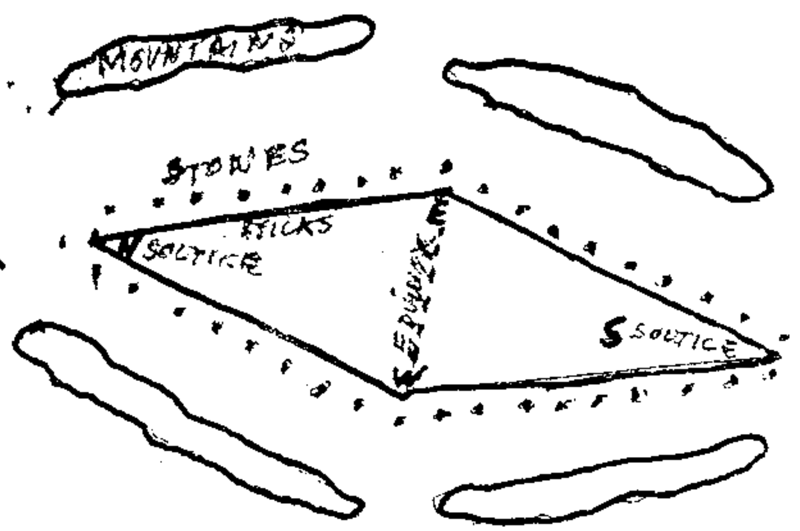


fig. 3-Gilbert Islands
stick-stone sidereal
compass

/Excerpted from Kurth, 1982:4)7

Interested in the petroglyph markings on the surface of the Kane-Lono rock, Kurth turned his attention to these weather-worn circling spirals and another geometric form, the apex of which seemed to point southeast. To render these more visually perceptible he chalked in the glyphs:

Ill.13. Side view of Kane-Lono diamond rock, looking across from west to east; Whitmore Village eastward in the distance toward Ko'olau mountain range

Ill. 14. Top view of petroglyph, from northeast.

The "pointing" figure which seemed to him to favor a southeast direction prompted Kurth in 1982 to develop an argument describing the stone as a compass and the circles as possibly indicating the north and south hemispheres, through which he then drew corresponding lines as in Illustration 15 below with a line drawn from northwest to southeast, and this commentary:

"The stone orientation is critical to my theory and I have located the four cardinal directions based on the complex geometric petroglyph on the stone's surface (see fig. 5 photo). Two rays extend to the right from the center of the upper circle creating an arc. This arc is exactly 47 degrees wide and bisected with a shorter ray. The sun was aligned with the shorter ray (short hole) of the two outer rays creating the bisected arc on 21 December, 1982. Based on this, the other ray (long hole) should align with the sun on 21 June (summer soltice). The bisect line should be the vernal equinox (true East) and be aligned with the sun on 21 March assuming that my theory is correct. I used this bisect ray as true East as a starting point to locate the other 3 cardinal points. Extending this bisect (equinox), I found that it almost bisects the extreme compass points on left and right of the stone. A line drawn at right angles to this EW line through the center of the 2 concentric circles almost bisects the extreme stone points on top and bottom of the photo (N&S). The upper concentric circle has 4 rings, each about 1½" wide (purlins?) which resemble Malo's description of Hawaiian circles and Grimble's account of the Gilbertese ancient astronomical parallels to the winter solstice. I could not count the rings in the lower circle with exactitude (4or5). This circle may represent the Southern

fig. 4 -Hawaiian sidereal compass ("stone canoe") from NNE

fig. 5- Petroglyph on Hawaiian compass stone (chalked in) from SW

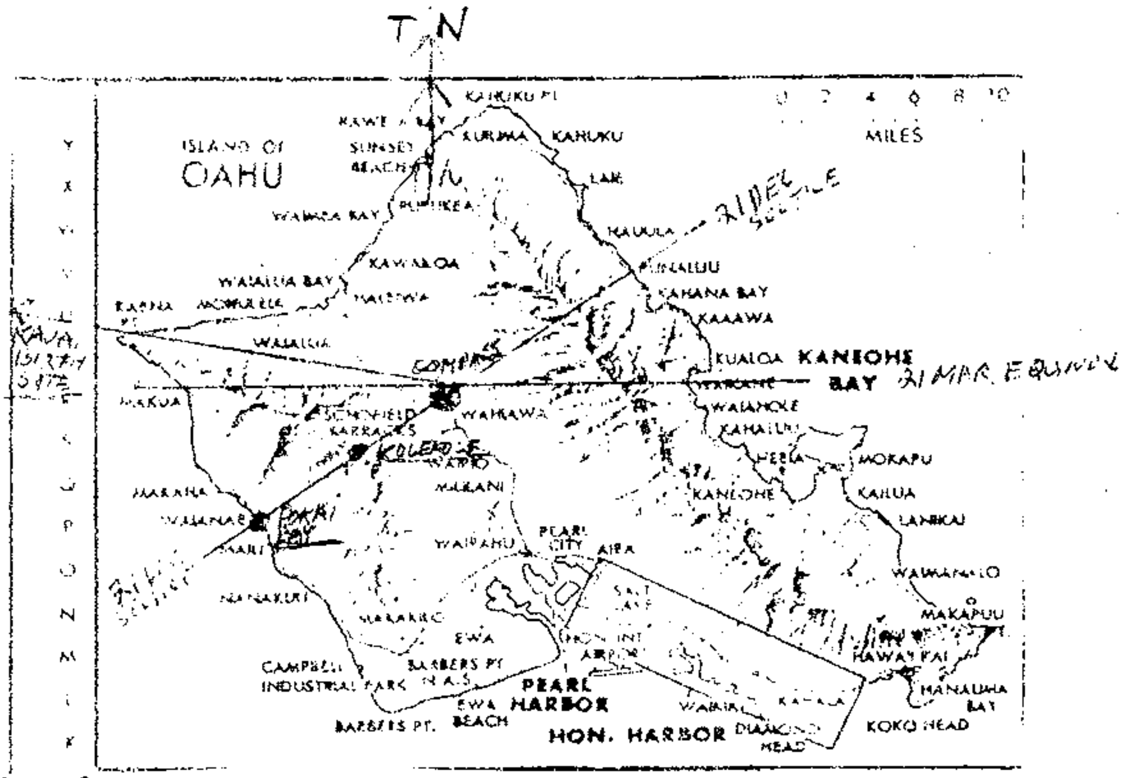
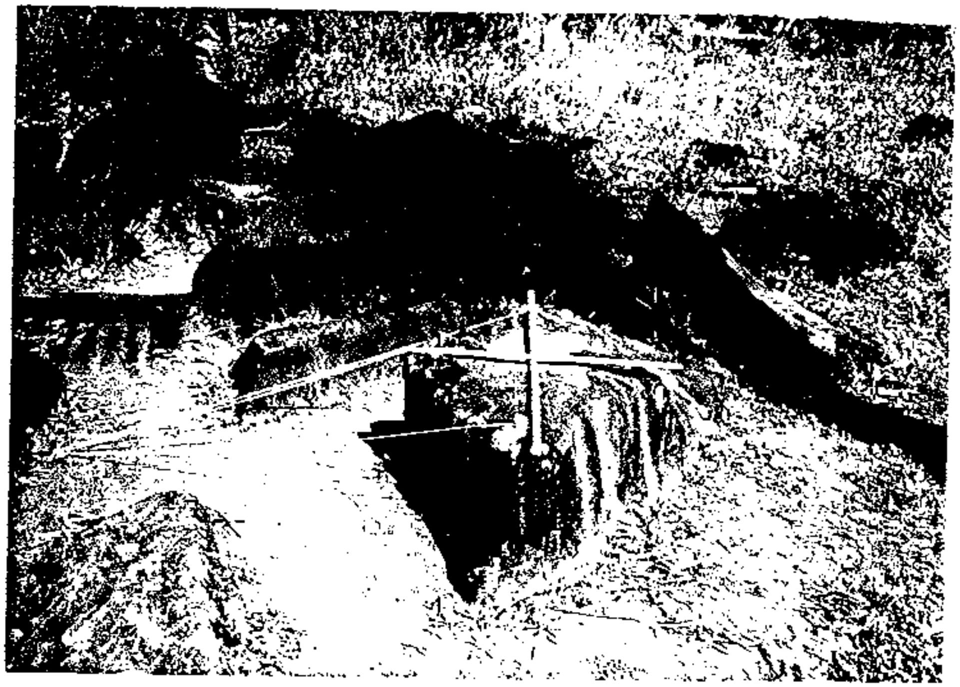


fig. 6-Hawaii compass stone site at Wahiawa & key bearings.

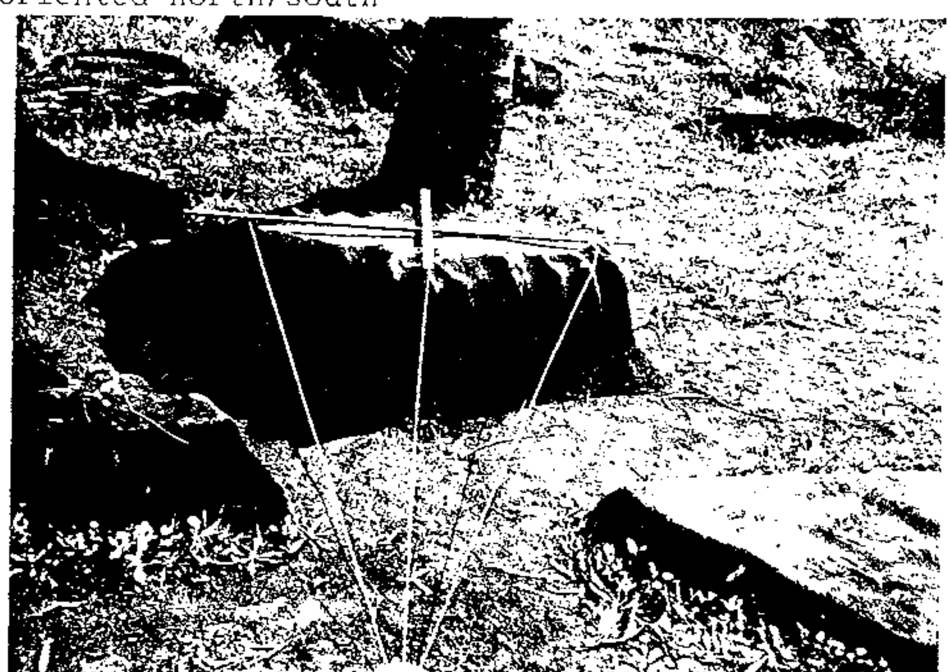
hemisphere. I have taken multiple readings on various days with a protractor and 2 compasses, allowing for magnetic declination, to further confirm my readings" (Kurth, 1982:6).

View across face of stone, looking from east to west.

In subsequent visits to the site, Kurth by means of sticks and string attempted to show how the stone aligns at its extreme apices north to south, and how from the observation of the equinoctial base line across the stone the northern and southern triangles formed by the bisect indicates about a 25½° arc for each half of the figure, the length of the diamond surface between the apices thus indicating the limits of the sun's swing north and south from the center of the rock to its northern and southern apices as the length of the year, the   axis to half that length thus defining a fixed radian measure:



Kane-Lono rock: view from north to south; stone is oriented north/south



View from west to east

Since it becomes necessary to give due consideration to someone's serious study and argument, such as was proposed by Harry Kurth with respect to the Kane-Lono diamond-shaped rock at Kukaniloko, Johnson on his behalf returned several times to the Kukaniloko site at the special times of the year when the sun is at its stand-still north and south and at equinox to see if the stone might be regarded as a compass.

The Kane-Lono rock is definitely oriented along its long axis to the north, but its sides are skewed from southwest to northeast at about 15° east of north, and from southeast to northwest at about 10° west of north. The equinoctial east/west base line across the shorter axis east to west falls across the rock at clear right angles from azimuth east 90° to west 270° as to be right on target at the deepest serrated pockets on the mid-sections of the stone. The over-all length, as reported by Kurth, was about one fathom, and height about 18 inches, or what could be the Hawaiian cubit length. That means that the rock, when measured by Hawaiians (if they were originally Hawaiians who etched out the diamond shape in the rock, unless natural elements made that shape to begin with), measures one fathom (ho'okahi anana) by one cubit (ho'okahi ha'ilima) at its longest and deepest axes (measuring upward from the ground surface). If the cubit were thus the important length, then the length of the rock is 4 cubits, and one 'iwilei (½ yard) would equal 2 cubits.

On the spring equinox of 1989 Johnson returned to the

Kukaniloko site to observe the setting sun from the heiau, or the same parallel as the Kane-Lono stone, although not from the stone itself (since trees interfere with the mountain range of th Waianaes), and found that the sun set just at the southern end of Mt. Ka'ala in the direction of Pu'u Kalena (3504 feet). We must accept the solstice sunsets photographed by Kurth until we have duplicated those views.

In Figure 1 (next page), I have plotted the equinox sunset as the sun dropped toward the mountain, and it would have continued to arch to the horizon at an angle impossible to observe without the clear horizon beyond the Wai'anaes for me to record in exact degrees of azimuth. But the sight of the sunset that end of Mt. Ka'ala prompted me to regard the pronunciation of that old Hawaiian name as "ka'a ka lā", the motion of the sun, in Ka'alā, rather than "fragrance" (ka 'ala). It would make more sense, since the whole ridge is called "back of the sun" (Kua-o-ka-Lā) and the prominent peak beyond Pu'u Kane is Kaupoku-hale (ridgepole of the house), signifying the local meridian overhead. The sky was thought to be the roof of the house (kaupoku), which is another Gilbertese analogy that is similar to Hawaiian metaphors of the sky. And, as for the "stone boat", or canoe compass, we must remember that the ancient Tahitian marae, which were the models antecedent to Hawaiian heiaus, were built so that the walls were marked by star posts, corresponding to the horizon <u>lua</u>, or azimuths, of rising and setting celestial bodies, the posts themselves the <u>tira</u> or "masts" of the canoe or supporting pillars of the sky, the horizon extended as though viewed from

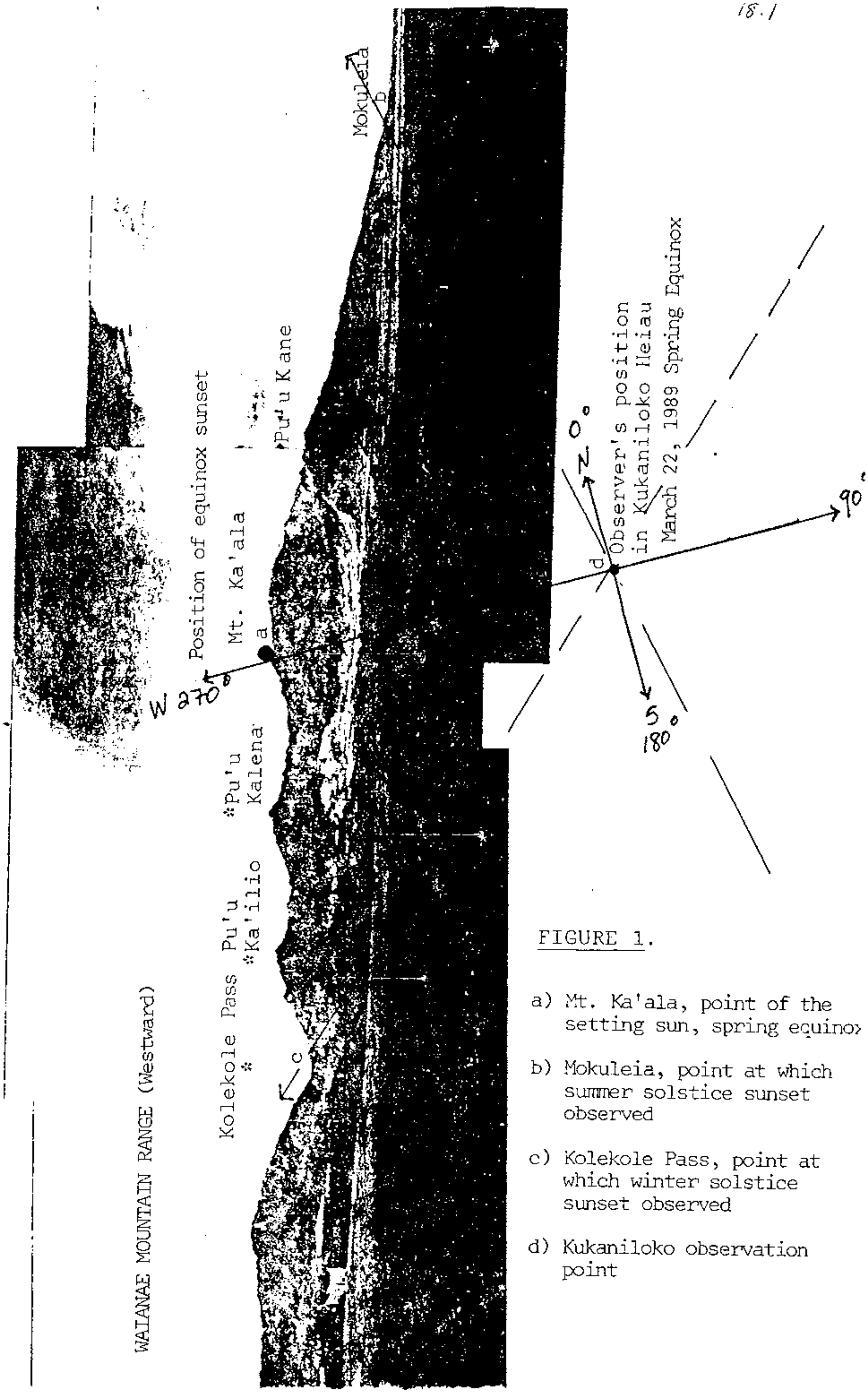


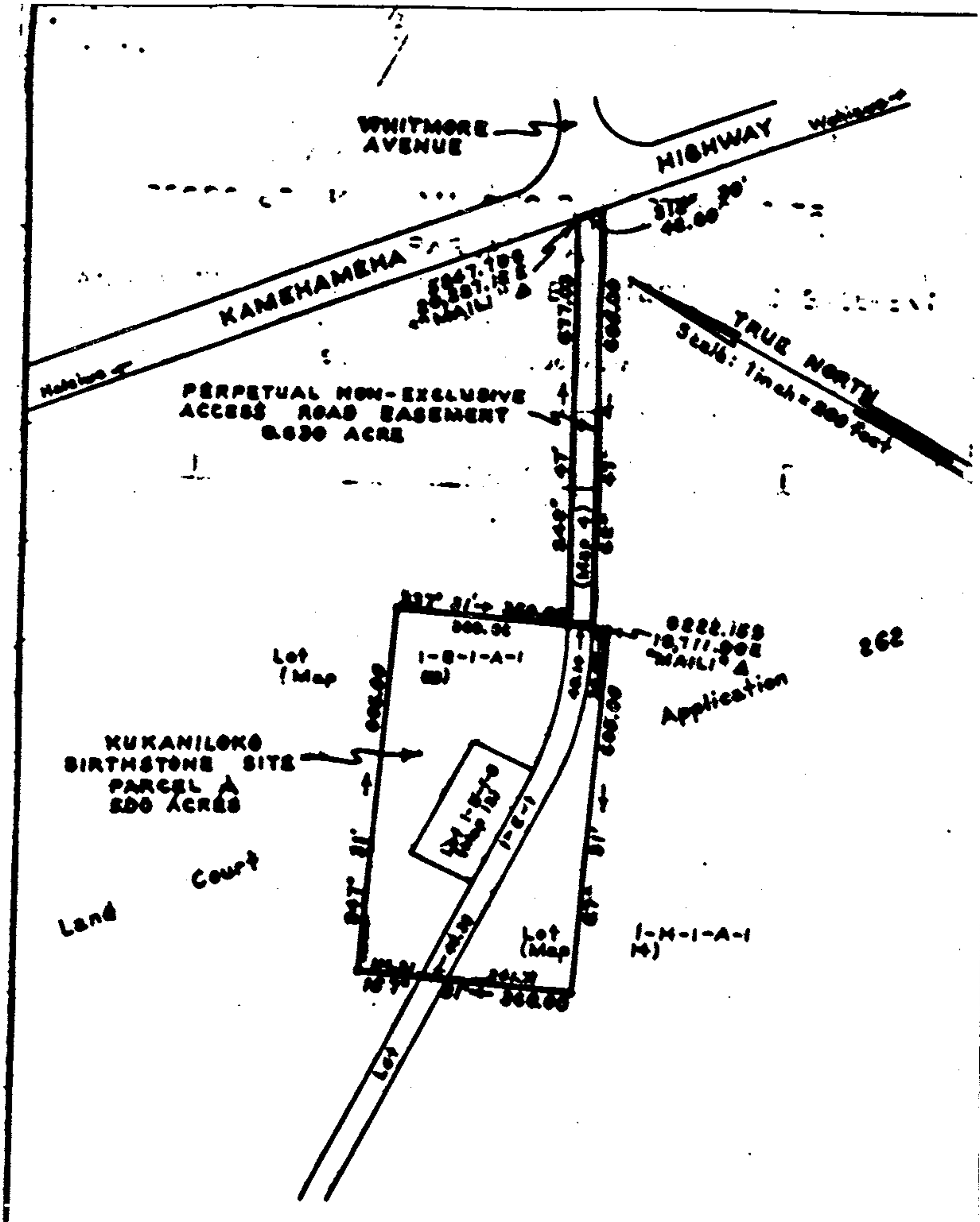
FIGURE 1.

a) Mt. Ka'ala, point of the setting sun, spring equinox

b) Mokuleia, point at which summer solstice sunset observed

c) Kolekole Pass, point at which winter solstice sunset observed

d) Kukaniloko observation point


WHITMORE AVENUE
KAMEHAMEHA HIGHWAY
Wahiawa
Haleiwa
TRUE NORTH
Scale: 1 inch = 200 feet
PERPETUAL NON-EXCLUSIVE ACCESS ROAD EASEMENT
KUKANILOKO BIRTHSTONE SITE
PARCEL A
Land Court Application
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vantage-point of a canoe deck. (For descriptions of the Tahitian marae, see Teuira Henry, Ancient Tahiti, Bishop Museum Bulletin 48, 1928: 131-174) The most sacred house on the Tahitian and Hawaiian temples was the fare manaha (Tahitian) and the hale manā (Hawaiian), probably derived from the Gilbertese maneaba sacred house, the required structure for which was described by H.E. Maude (The Gilbertese Maneaba, 1980). (Commentary on the Gilbertese "stone boat" may be found in books by David Lewis, such as We The Navigators; see also Sir Arthur Grimble, "Myths From the Gilbert Islands," in Folklore, No. 33, 1922:91-122; No. 34, 1923:370-374, and "Gilbertese Astronomy and Astronomical Observations," in the Journal of the Polynesian Society, No. 66, 1921:271-290). I have also included in the appendix to this paper an excerpt from my book, The Kumulipo Hawaiian Hymn of Creation, the opening chapter on Hawaiian calendrical computation with reference to Micronesian computation and the diamond analogy (Johnson, 1981:21-25).

Once again, if thirty-six nobles were required to be present at the Kukaniloko births, this particular number has calendrical overtones, since the equivalent number of ten-day weeks (36 anahulu) totalled the 360 days short of the five-day intercalation required to complete the tropical year.

If Kurth's interpretation, or extrapolation of the Gilbertese stone boat analogy is correct in explaining the Kane-Lono rock at Kukaniloko heiau, we might extend the Kane-Lono rock's uses further as it points north and south along its main axis, its extremes and length measuring out an arc between the solstitial extremes of the ecliptic marked by the sun's stand-stills at either extreme, describing an anble of 50.1° or the sun's amplitude at the latitude of Kukaniloko.

However, since the view is more open toward the circumpolar regions, it is perhaps more likely that the open central corridor of Oahu between the Waianaes and Ko'olaus gave prehistoric viewers visual access unobstructed to meridian passages of prominent northerly and southerly stars. This may explain why Kane-Lono rock on its southwest to northeast side tilts to about 15° east of north while its southern apex points directly south to the position of the Southern Cross at meridian (S 180°). Meridian passages of the sun by day and meridian transits of the stars by night, and the moon's swing north and south against prominent peaks of the mountain ranges east and west of Kukaniloko would have given the priests ample calendrical and spiritual contemplation to prophesy in behalf of each infant chief.

" A HAWAIIAN STONEHENGE DISCOVERED"

A major discovery on 2I December, I982 of an ancient Hawaiian Observatory and multi-purpose sidereal star navigation compass ("stone canoe") and training site

BY

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PH: (808) 422-554I

I believe that I have discovered an ancient Hawaiian Observatory and multi-purpose sidereal star navigation compass("stone canoe") and training site that is more sophisticated than any so far recorded in the Pacific area and that may rank with Stonehenge and other similar sites in functions and complexity when fully analyzed!

I have researched pertinent fields(ancient Pacific navigation methods, ancient Astronomy, Archeology, Anthropology, etc.) in an attempt to determine if anything has been published prior pertaining to the use of this site for a hidden observatory or for navigation training purposes. The site is listed in "Sites of Oahu", 1978, as "Kukaniloko, Birthplace of Alii"-Site #218. References therein only describe practices related to royal births conducted at the site.

A thorough search of references was conducted at the Bishop Museum library, The State of Hawaii library, local, and military libraries, with no findings of a site use other than birthing. These sources however, provided a wealth of information for this and a planned publication. References used are listed in the back.

I am a novice in each related field however basically knowledgable in this specific area because so little has been published on this subject. This is understandable because of the strict tabu at this site in ancient times coupled with traditional navigation secrecy. As a result, most references on Hawaiian methods are particularly vague and scarce. The general thread of comments in references reviewed is that "Nothing new is expected to be forthcoming from Hawaii in the future".

Similarity comparisons in ancient Pacific navigation practices and devices, and similar sites provide some of the evidence but actual petroglyph measurements, interpretation thereof, and stone orientation and bearings therefrom provide my strongest proof.

I am a retired Army Major with knowledge in map reading and compass methods. I have been a resident of Hawaii for the last 12 years, a former U of Hawaii art student, and now a professional seascape artist. An artists' imagination contributed to this discovery but I have made a supreme effort to stick to facts and not let artistic license creep in.

This premliminary paper is only intended to announce my discovery and is not intended for the public. I am making select distribution to a few agencies and authors who are familiar with the area of study. I plan to enlarge my scope in a future publication. I have been working independently up to this point however I now need expert comments, advice, confirmation of my discovery, and assistance from addressees, particularly in the areas of ancient Astronomy to include 1200 AD star charts and tables, ~~and~~ ancient Pacific navigation methods related thereto, and ground survey assistance.

My initial discovery was made on 21 December, 1982- the Winter soltice date!!

Harry G. Kurth

Harry G. Kurth

References indicate that two way voyages to the S. Pacific were in being in I200 AD and ceased about I500 AD, 300 years before modern navigation instuments were introduced into Hawaii. The "birthstones" were put in place in early I200 by a chiefs son whose father was the first to arrive from one of the Southern groups and established himself in the Hawaiian group on Oahu. The location became a Royal birthing site and tabu to all but the highest chiefs. The site, near Wahiawa, is assured permanent protection by the Daughters of Hawaii. Kukahiloko is described as the birthing stone upon which the wives of the highest royal chiefs gave birth witnessed by 36 high chiefs(the same number of stones are supposed to be aligned in two rows). From descriptions given, it is not possible to pinpoint the birthing stone but it has been described as "The stone to be trusted"for if anyone came in confident trust and lay properly upon the supports, the child would be born with honor, etc." An early writer indicates that the site was allready a sacred place occupied by a tabu high chief and that birthing here added a special divine gift to the birth. It is possible therefore that "Kukaniloko, the stone to be trusted" may allready have been in place much earlier than when the 36 stones were added in I200 AD for some more important purpose than even a royal birth. "A stone to be trusted" in my opinion, more accurately describes a stone star compass! This then is what I believe I have discovered! (see fig. Iphoto).

A version of a stone compass("stone canoe") as described in use in the Gilberts (see fig. 2 sketch) where a similar device used for navigation exists is used in the training of navigators and is a multi-purpose device which is diamond shaped and doubles as an island to teach geography and astronomy and as a canoe in which a trainee sits to learn star movements, island wave effects. ALSO In the Gilbert Islands, a diamond shape is established at the training site by placing sticks in line with the horizon line of the surrounding mountains and then placing 36 stones around the perimeter(see fig. 3 sketch)to teach navigation star path techniques by indicating the rising and setting points of I8 key navigation stars(a sidereal compass). The Hawaiian sidereal compass (stone canoe) is also diamond shaped(see fig. 4 photo) and is a more sophisticated compass by far because it incorporates a complex astronomical plotting petroglyph on its surface and has permanently affixed its star paths, wave patterns,etc. by a series of bumps and serrations along its perimeter--A complete observatory on a stone!! Its sides are aligned with the two mountain ranges flanking it and the peaks and valleys are reflected in the form of bumps for mountains and grooves for valleys. I believe some of these features are aligned with travelling star paths and others (or some of the same i.e, multi-purpose) may reflect the wave pattern of Oahu or some destination or general wave lore taught to ancient navigators.

The stone orientation is critical to my theory and I have located the four cardinal directions based on the complex geometric petroglyph on the stones' surface(see fig. 5 photo) Two rays extend to the right from the center of the upper circle creating an arc. This arc is exactly 47 degrees wide and bisected with a shorter ray. The sun was aligned with the shorter ray (short hole) of the two outer rays creating the bisected arc on 2I December,I982. Based on this, the other ray(long hole) should align with the sun on 2I June(summer soltice). The bisect line should be the vernal equinox (true East) and be aligned with the sun on 2I March assuming that my theory is correct. I used this bisect ray as true East as a starting point to locate the other 3 cardinal points. Extending this bisect(equinox), I found that it almost bisects the extreme compass points on left and right of the stone. A line drawn at right angles to this EW line through the centerof the 2 concentric circles almost bisects the extreme stone points on top and bottom of the photo (N&S). The upper concentric circle has 4 rings , each about I½" wide (purlins?) which resemble Malos' description of Hawaiian circles and Grimbles' account of the Gilbertese ancient astronomical parallels to the winter soltice. I could not count the rings in the lower circle with exactitude (4or5) . This circle may represent the Southern hemisphere. I have taken multiple readings on various days with a protractor and 2 compasses , allowing for magnetic declination, to further confirm my readings.

I have recorded many other geometric measurements and found angles of 23½, 30, 45, 47, 60, 90, I20, in a complex geometric pattern that requires further study before publication. The stone surface is a little over 4 ft. in length and 2½ ft. wide. It is a very precise diamond shape with angles of II0 on E&W and 70 on the N&S ends. The compass lies on a 6' x 3' base(depth unknown) and rises I8" from the ground(6" base and I2" stone canoe) or upper portion. The North half of the stone is somewhat concave, the center is flat, and the South half slopes off to the SE as does the terrain of the island from where the stone is located. The upper surface appears to be a topographic replica of the Oahu surface.

I have taken some bearings which have proven to be important to prove my theory(seefig. 6 map) . Utilizing the compass stone as a center point, a true bearing of 237 passes directly over Kolekole Pass stone(site 2I4) , through a cleft in the pass, and is on a direct line with the Pokai Bay peninsula which was an ancient astronomical and navigation training site (#I53). Continuing further on this bearing would bring an ancient navigator to the vicinity of the Gilbert Islands! An artillery marker with the cardinal directions on a brass plate is located within I0' of the Kolekole stone and served to confirm my converted compass readings. The back bearing of 67 deg. coincides exactly with the winter soltice(short hole) ray on 2I Dec. The Equinox line has some even more interesting landmarks on its "ley" path that will require survey confirmation. A bearing of 290 deg. passes directly over Kaena point and 90 miles away passes directly over the only other"Royal birthsite" in the Hawaiian Islands ending at the summit of Kauais' highest mountain. This bearing is the key bearing that bisects the entire Hawaiian Island chain and is similar to the entire S. Pacific pattern of island groups. The arrangement of the birthing stones around the compass stone all lie in a WNW to ESE direction generally. If I were able to lift the compass stone and place it exactly where I believe Tahiti to be, I would have to return it to its present position and orientation.This brings me to the puzzling arrangement of the stones at Kukaniloko. The site description implies that they are in neat rows but this is not so. At first glance it appears that there is no rhyme nor reason to their placement except for a clue in one report by Thrum in 1912_"And the face was to the right side". The large majority of the stones have their sloping or low side to the East or SE, or right as facing from the road(left side in fig.1). This is the direction that most landfalls are made from on S.Pacific islands because it is the protected side of most islands. The stones have another unusual feature: many have circular depressions of varying size(some 12" across and 6" deep) and cleftsof varying size. I have taken photos of the most distinctive stones from a generally SE direction and plan to contact sources who may recognize one or two as stylized islands with craters, valleys, streams, etc. which may have been used to train ancient navigators. If a few can be identified as to location, the rest may fall into place. I have measured the distance and bearing of each of these distinctive stones from the compass stone(some from as far away as 68') and reduced this to a scale of 1/8 to a foot and plotted each stone for future comparison to Pacific island groups or individual islands within groups.

The general area of the site (see fig. 6 map) closely resembles one at Mystery Hill in N.H. described as follows: "There was some--thing about the place, the way you stand at the bottom of a natural bowl with hills all around to the East, North, and West but open to the sun toward the South. It was a natural observatory. There are peaks and valleys in the hills which could have made marking points at critical times in the solar year"-- Later, the writer, Byron Dix found 7 out of 8 stone markers on the ridge line for soltice and equinox directions. Kukaniloko is centered on the Lihue plain between two mountain ranges. It also opens to the South! Any change of more than a few yards in any direction would negate the bearings indicated and any soltice alignments.

The Kolekole stone (site 214) has been described as a boundry which I dont deny however again as at the birthing site,I believe it had another more important function in ancient times: A backsight for the winter soltice accuracy required for the training of 2 way ocean navigators and actual 2 way voyages(possibly related to the Kauai birthsite for resection and triangulation plotting).

It has been difficult for me to believe that a discovery of this magnitude could have been overlooked for 800 years.The combination of a high tabu and navigation secrecy insured its confidentiality in ancient times.After Hawaiian open ocean voyaging ceased in about 1500, the navigation secrets died with it. By the time Cpt. Cook arrived 300 years later with his modern navigating instruments, Hawaiian methods had long been forgotten. It is said that the best kept secrets are hidden in the open like a diamond in a glass of water. -- This is Kukaniloko!

This multi -purpose site may also have been used for calendar plotting, eclipse prediction, and may have a use today for the training of Hawaiian navigators in the use of the sidereal compass.

If a few remaining navigators schooled in the ancient art could be brought to Hawaii to view this site, it may revive some memories of ancient training methods and Kukaniloko may yild even more secrets. Even further, if this visit could be coupled with the training of a few Hawaiian navigators (recorded and documented) in this ancient art for a future Hokulea voyage, the ancient "bridge" will have been rebuilt.

No part of this paper may be published without my consent.

Harry G. Kurth

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(6) Corroborative evidence from similar sites (Central O'ahu), Kukaniloko Heiau: Shadows and Petroglyphs

Kurth's investigations of the Kane-Lono stone petroglyph of concentric circles turned his attention to other related petroglyphs, such as a Pu'uloa, Hawaii. The interest in the circles drawn at Kukaniloko led to shadow observation from the stone.

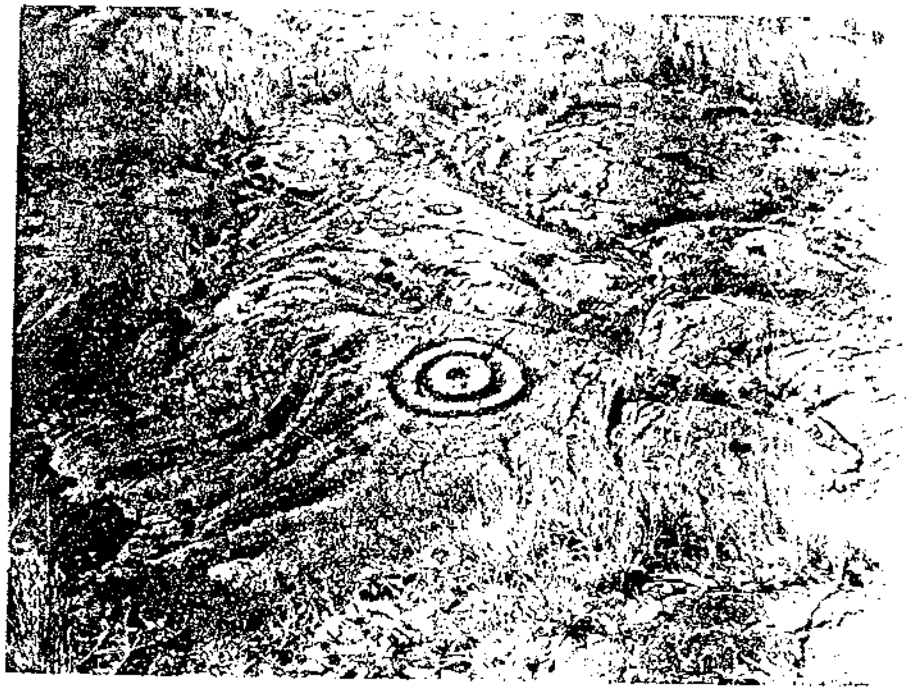
A progressive sequence of these questions regarding such petroglyphs and their probably use, as of shadow-use, is laid out here. Kurth was also, because of the occurrence of pock-marks in some of the boulders at Kukaniloko, interested in including them in the overall study he made of the site.

(a) Kaho'olawe shadow-watching (March 1992). This was done purely as a learning device, some of which were store-bought shadow-watching tools we had in the kit-bag, such as a portable sun-dial, and on-the-site manufactures, such as a shadow pole or a coral stone with a grass stalk (made by Captain Milton Roth to illustrate why, in the northern hemisphere, the noon shadow points north, and why in Hawaii, the time in which the noon shadow points south is a short time, vice versa in the south.

The shadow stone as a hand-sized rock was also used, like the stick, to show that on a level, such as the ground, the motion of the sun against the rock will indicate the azimuth (at sunrise/sunset) and, over a period of time, the analemma for a particular latitude. During the daytime, however, as the shadow moves between sunrise, noon, and sunset it will stretch beyond infinity (long shadows), grow shorter as it declines toward noon, be at its shortest at noon, [disappear twice when the sun is at zenith, twice during the year, when it is moving into your latitude/zenith on its way north (between March and June) and again on its way south (July to December) only in the tropics.

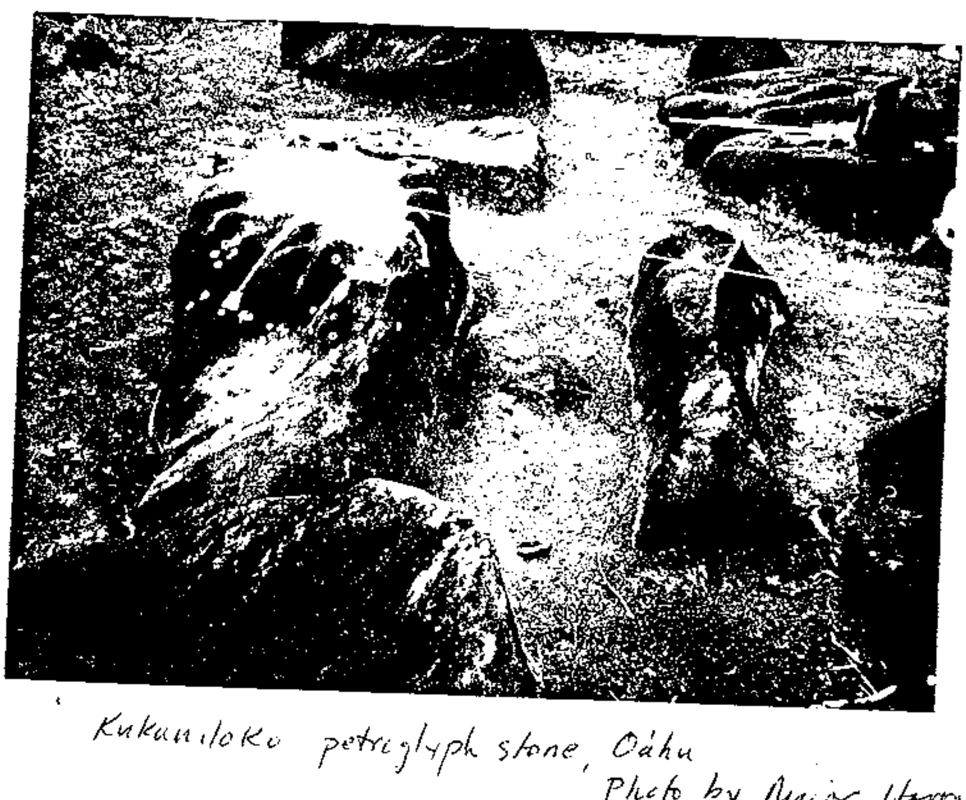
29 June 1985 Noon Zenith Passage; No gnomon shadow

5" vertical gnomon



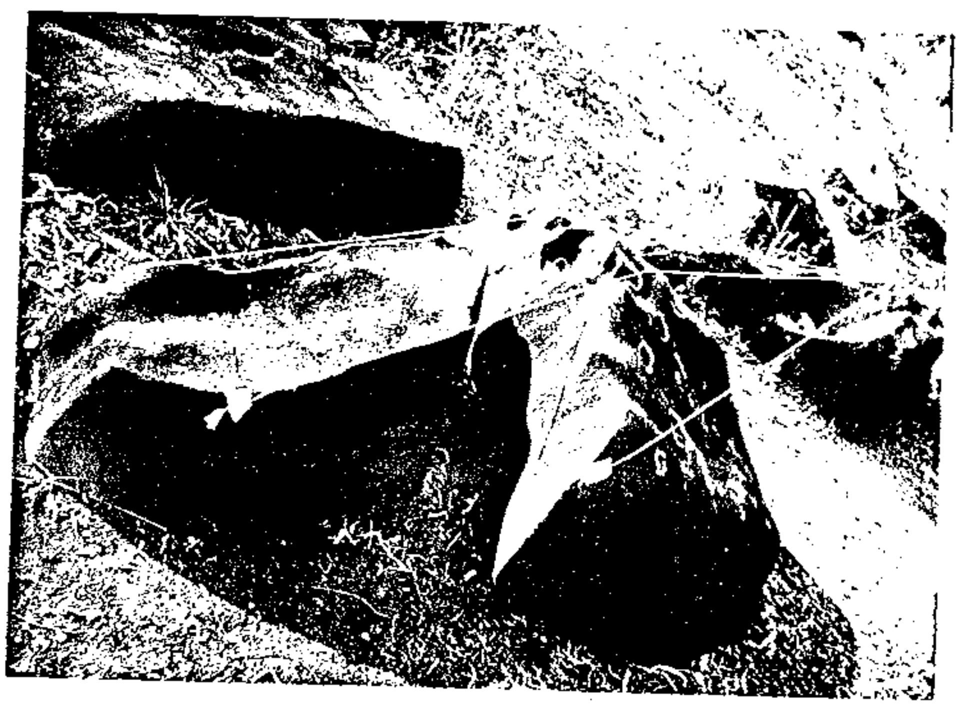
Puuloa, Hawaii petroglyph + cupule
"Piko" type

Photo by Major Harry Kurth
1985



Kukaniloko petroglyph stone, Oáhu
Photo by Major Harry Kurth

Depressions / Kukaniloko Rocks



Between Kurth's death about 1988-89 and 1990, while following through his work as a memorial effort desired by his surviving widow and children, who donated his material for such a project to be done, I went out to Kukaniloko Heiau toward evening sunset to check on Kurth's alignment data, and on one occasion, watching the setting sun at the June solstice drop below the horizon, at that moment a shadow dagger appeared on the Kane-Lono rock, dramatically slicing the circle petroglyph with a diagonal cut through the center.

Next fall, at autumn equinox I returned again to the site, and the same thing happened when the sun dropped behind Mt. Ka'ala on the southern cliff, just before Akolekole Pass. As at the previous solstice, the dagger crept swiftly across the rock before the greater shadow of the Wai'anae Range and the tree shadows eclipsed it.

At another time I went there before sunset, and it happened also, but the passage of the shadow, when the sun is still high afternoon, took longer across the petroglyph, between 35 and 45 minutes then and at other times when I was there before sunset.

The following set of photographs, taken by Alyce Ikeoka of Lanakila Intermediate School in Kalihi, is of the shadow dagger passing through the circle petroglyph before sunset about four days after the autumn equinox. Setting sun is at the southern end of Mt. Ka'ala.

The rationale for attempting petroglyph study in relation to shadow- or other time factor connected with petroglyphs, rock depressions, as at Kaho'olawe in September, 1992 was an attempt to find other kinds of practice connected with sun-, moon-, star-, planet- watching, if to determine how other facets of time and space were part of experimentation/observation in ritually important places.

15.1

15.2

(7) The Significance of the Kaho'olawe Petroglyph Study for Hawaiian Archaeology and for future Archaeoastronomy Study.

This dimension of the September 1992 field trip was very rewarding and may, perhaps, be of far greater significance to the related fields of petroglyph art, Hawaiian art motifs in rock art, archaeology, and archaeoastronomy.

Dr. Edward Stasack's work, in addition to the enormous work done by Robert J. Hommon, Senior Archaeologist, Hawaii Marine Research, Inc., in 1980, is appreciated for the contribution it made to the 1992 experience on Kaho'olawe overall, and much is owed to Rowland Reeve and Meleanna Meyer whose assistance was invaluable in the field.

I append Dr. Stasack's report to this consultant, to which I also add photographs of work he also has commenced elsewhere in Hawaii, especially with regard to cupules.

I also append the Har Karkom archaeology, with 35,000 examples of rock art (page 38)[Biblical Archaeology Review, January, 1993] as an encouragement for attention to Hawaii's store of petroglyph art.

Photo by M. Meyer

Sun's shadow cast into cupule Kaho'olawe
Loa'a Site Sept. 1992

Kaho'olawe: pock mark or cupule?
man-made or natural?

21 September 1992
Submitted to Professor Rubellite K. Johnson and the Kaho'olawe Island Conveyance Commission by Professor Emeritus Edward A. Stasack, assisted by Rowland B. Reeve

Kaho'olawe Petroglyphs

A preliminary report on sites at Kanapou Road Access (named the Loa'a site), Hakioawa, Ahupuiki, and Ahupu, visited 8-10 Sept.'92.

Personnel included Archaeologist, Rowland B. Reeve; Artist, Meleanna Meyer; and Edward Stasack

As a reference, the report, "Kaho'olawe Petroglyphs: Site Forms State Historic Preservation Division", was used. It was compiled from site forms prepared by Archaeologists Robert Hommon, Chuck Streck, and others unnamed in the report. These site forms were completed during the island-wide archaeiological survey of Kaho'olawe conducted between 1976 and 1980.

Purpose of Survey:

1. To identify any petroglyphs with possible archaeoastonomic associations, connections, or implications.

2. To briefly assess the potential cultural, historic, and artistic information the petroglyphs provide.

3. To assess the physical condition of the petroglyphs with particular attention to the problems of erosion and recent petroglyph making activity.

4. To make preliminary recommendations for the protection, preservation, and conservation of the petroglyphs.

Introduction: The petroglyphs of Kaho'olawe are a microcosm of Hawaiian rock art. The broad variety of styles and various overlapping of images contribute to the notion that Hawai'i was comprised, not of a single culture, but a number of subcultures with provincial uniqueness. The need perceived by Kamehameha for unification provided the basis for his great achievement. The petroglyphs are beginning to tell us more about such things as this, and must be preserved by scientifically recording them.

Recording is not invasive. It takes nothing from the petroglyph or the site. It simply provides a permanent record of the image. Nothing is removed. Much is gained.

Archaeoastronomy: A boulder found at the Kanapou Road Access, Site 110 Feature BU (hereafter called Loa'a, meaning 'found' in Hawaiian, a name for the site agreed upon by the participating group) not previously reported or recorded may have an archaeoastronomic function. It merits further investigation. The boulder is a large, flat slab set, it appears naturally, upon another boulder, basically horizontal but with the west end slightly elevated. It has several petroglyphs, including human figures, a turtle, a possible kite or winged figure, a number of badly eroded images, and a group of cupules. The erosion of the images here is an example of the alarming rate of deterioration of the Kaho'olawe petroglyphs.

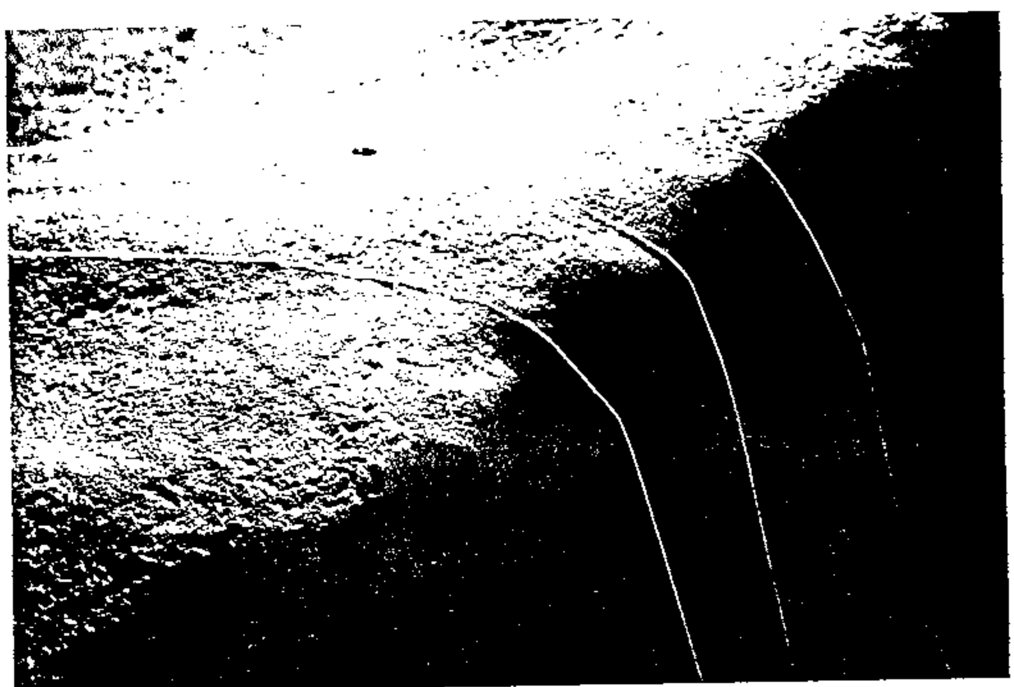
The cupules on this boulder are very interesting. There is a sequence of 20 or 21 of them irregularly spaced along the edge of this boulder. They vary in depth from one to 4½ cm, and extend along the perimiter from the NE to SSE. These could have a relationship to moon cycles or to retrograde planetary movements. A connection to ancient Asian sun dials is worth investigating. Further research is definitely recommended. (This investigator is not qualified to provide a conclusive statement other than that there is no other similar alignment of cupules in Hawai'i. The site at Kukaniloko on Oahu does suggest that the Hawaiians utilized petroglyphs to mark seasons, and possibly much more. Kukaniloko does not utilize cupules. However, several conformations of cupules at Pu'uloa, Puna, Hawai'i, do suggest archaeoastronomic associations.)

Cultural and Historic: The Kahoolawe petroglyphas are undoubtedly a source for cultural and historic information about the Island and, by extension, about Hawaiian petroglyphs as a whole. They are consistent with and support conventional archaeological findings regarding occupation periods and radiocarbon dating at some sites. They may be instrumental for future dating of occupation periods and as signposts of cultural change. For example, there is evidence of four or five distinct periods of petroglyph making activity at Ahupuiki, suggesting that there were several periods of occupation of this gulch. This observation is based on the presence there of several styles, the overlapping of images, and "renewal" by later pecking over existing lines of older underlying images.

Some images suggest connections to stories and myths about such legendary characters as Halulu and Kaupe. It is almost certain that an image such as the runner at Hakioawa is the commemoration of a great running acheivement, (possibly someone such as Aholoholo carrying an important message?).

Physical Condition: Many of the Kaho'olawe petroglyphs, probably the majority of all those viewed at the four sites, are eroded to

Petroglyph site study by Dr. Edward Stasack; team included Meleanna Meyer, Rowland Reeve.



Pecked cross on petroglyph rock [Photos by Meleanna Meyer].

a shocking degree, more than similar petroglyphs in similar situations on the other islands. Some have been effaced, are gone forever! This erosion seems to have been severely accelerated by environmental changes on Kaho'olawe during the late historic period. The principal reason, suggested by several archaeologists, seems to be windblown soil and sand, exposed by the loss of grass and other vegetative ground cover which previously buffered the petroglyph boulders. Some petroglyphs are being sandblasted out of existence.

One of the boulders at Site 110 Feature AP 7a which had supported a number of petroglyphs as recently as the late '70s is now totally bare. In general, images on the lee side of boulders are deeper than those on the windward side, supporting the idea of erosion by windblown soil and sand. The situation is critical.

Recommendations: It is imperative that the petroglyphs of Kaho'olawe be professionally and scientifically recorded immediately or many of them will be lost to us forever. A priceless source of cultural and historic information will slip away. Everyone will be able to breathe a little easier when the petroglyphs are recorded and are part of a permanent data base. Attention can then focus on a management plan for preservation and protection.

The recording should be accompanied by the newly developed methods of scientifically dating the petroglyphs. This must be done before erosion removes the "varnish" and encapsulated organic material which provides the raw material for dating. Successful dating would be a giant step for everyone doing research into the ancient Hawaiian culture.

There is excellent potential for finding unrecorded petroglyphs. During our very brief survey the new boulder with cupules at Loaa was found. Others undoubtedly await rediscovery.

Previous inaccuracies in the recording of the petroglyphs need to be corrected. Early studies were hurried, incomplete, and done by those who were not necessarily as skilled at recording as they were in their own area of expertise. Given the preliminary nature of the initial surveys and the limited time available to record these sites it is not surprising to find some inaccuracies. Inaccurate data is worthless.

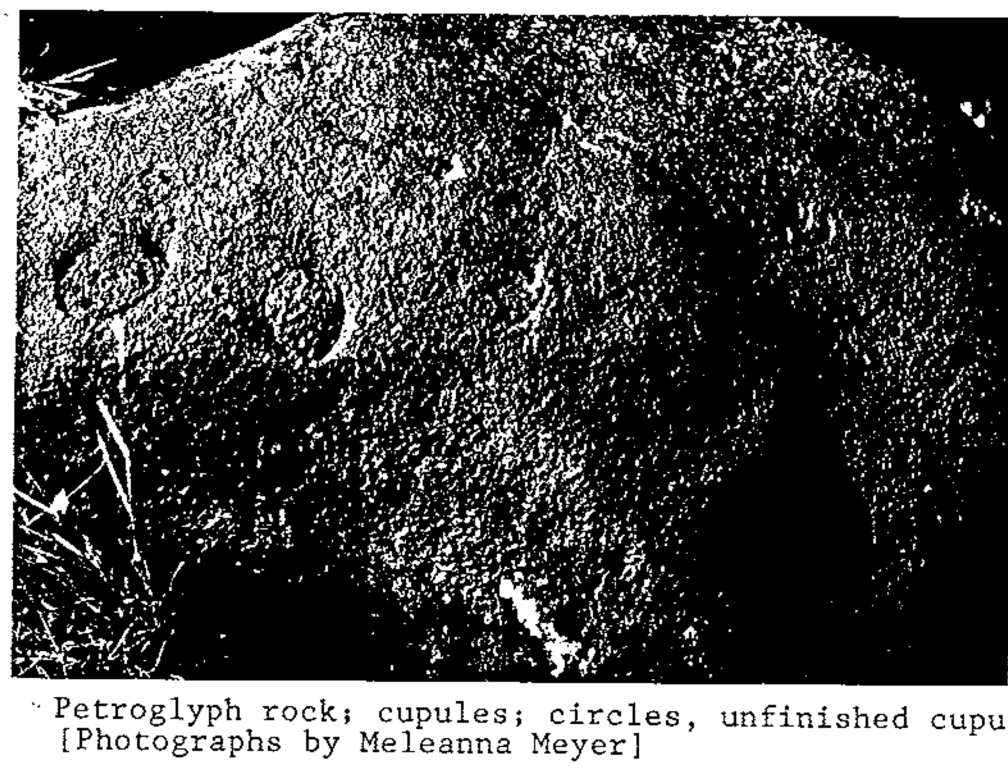
The petroglyphs of Kaho'olawe are still among the least changed evidence of the Hawaiian precontact period. They must be preserved and recorded while we search out their meaning and try to understand what they are telling us about ancient Hawaiian culture and history.

·Petroglyph site; weathered cupules; R.Johnson
[Photograph by Meleanna Meyer]

Inclined rock, with gouged surface; cupules, or natural weathering?

Note sun shadow half-circle in depression as an indication that the time is mid-morning. [Photograph by Meleanna Meyer].

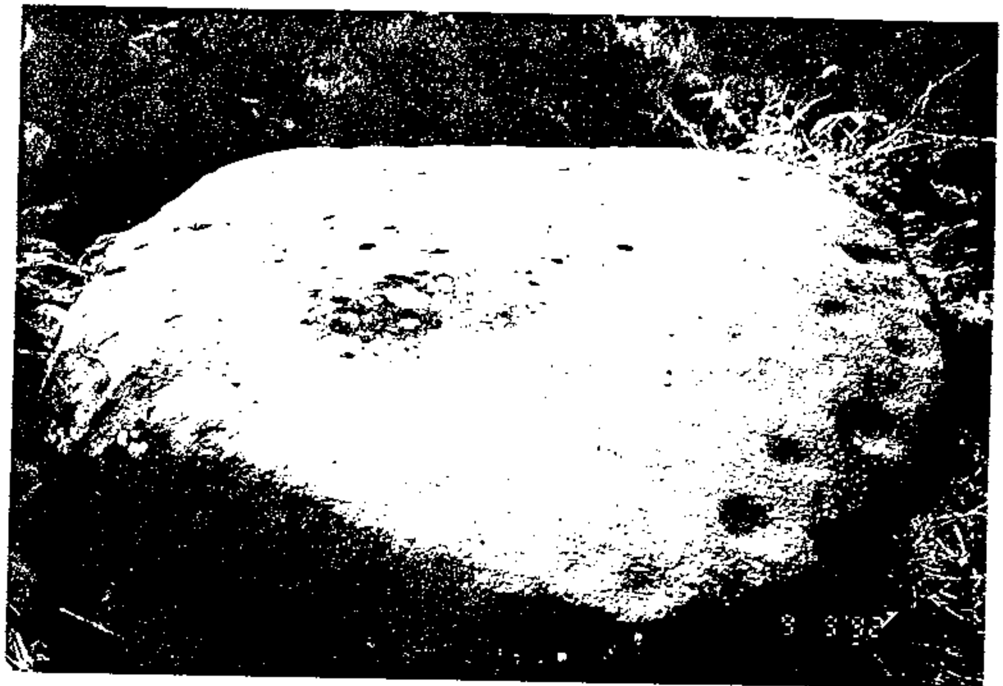
Petroglyph rock; cupules; some weathering?



Petroglyph rock; cupules; circles, unfinished cupules?
[Photographs by Meleanna Meyer]

Petroglyph rock, cupules; Meleanna Meyer [Photo by R. Johnson]

Petroglyph rock, cupules; Aki Sinoto [Photo by R. Johnson]



Petroglyph rock/cupules. [Dr. Stasack and team counted about 21 cupules, those on the northern side wind- and weather- eroded; southern side still able to be pockets for any number of things, i.e., pebbles, stones, or serve as containers for liquid, such as kukui nut lamps, or as mortar grindstone cups for medicinal preparations, etc. Cupules have not been studied in Hawaii, and they are beginning to attract notice, beginning with Dr. Stasack's investigation of these Kaho'o-lawe sets. For whatever purpose they may have served, probably a number of purposes, they were gouged out by human agency and then smoothed out by polishing, a process indicative of the neolithic stage of Hawaiian stonework evident in other kinds of stone-tool making].

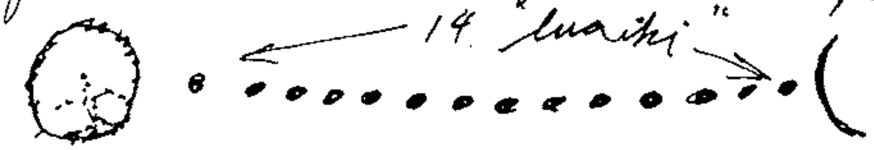
26 Sept 92

Edward A. Stasack
HC - 30 - 895

Rudy,

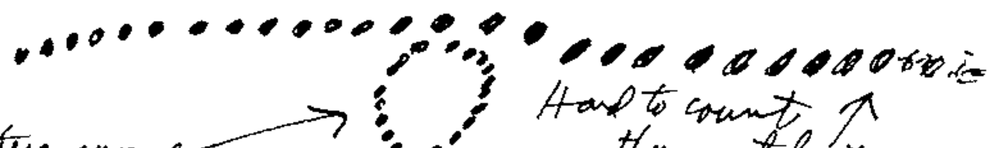
The photos of cupules (mini luas) from Puiiloa might have archaeoastronomic potential.

full moon? half moon?



↑ this "circle"(?) is not that defined and may have a figure superimposed.

Here there are between 25 and 28 "luaiki"



Pu'uloa, Hawaii petroglyphs   Photo by Ed Stasack

Puuloa, Hawaii cupules and circles
Photo by Ed Stasack

30,000-Year-Old Sanctuary Found at Har Karkom

Mt. Sinai was a sacred site long before Moses came to it, if the theories of archaeologist Emmanuel Anati are correct. Anati, who has been discovering and excavating archaeological sites and recording rock art in the Har Karkom area since 1980, believes that this mountain in Israel's southern Negev desert is the location of Biblical Mt. Sinai.*

In 1992, the 19th expedition to Har Karkom (tent camp pictured at right) made what may be the most extraordinary discovery yet at this remarkable site. On the eastern ridge of the Har Karkom plateau, they found a group of artifacts that Anati interprets as the remains of a religious sanctuary dating to the initial phase of the Upper Paleolithic period (30,000 years ago). The finds lay in the open in an area of about 30 to 40 yards by 15 to 20 yards, at the entrance to a trail leading down to the desert floor.

The most striking of the objects are some anthropomorphic standing stones of flint (opposite). Fifteen of these monoliths remain standing, while 25 to 30 have fallen (or have been moved from their original location). Measuring a little more than 3 feet high, the monoliths were apparently chosen for their naturally anthropomorphic quality and then slightly retouched to enhance the effect. The style of the stone-flaking technique used is similar to that used by the Near Eastern Aurignacian culture of 30,000 years ago. The interplay of natural shape and human modification can be seen in the photo: The stone that rests as a head on the monolith at center features a naturally shaped "nose" and two "eyes" that have been gouged out by humans. Some of the monoliths, however, appear to have been redressed far more recently, probably within the last 2,000 years, judging by the relatively light patination on the surfaces where they have been worked.

The site also contains numerous flint implements in the style of the Near Eastern Aurignacian culture and about 220 naturally anthropomorphic flint pebbles (also occasionally retouched) found on the ground thoughout the sanctuary area.

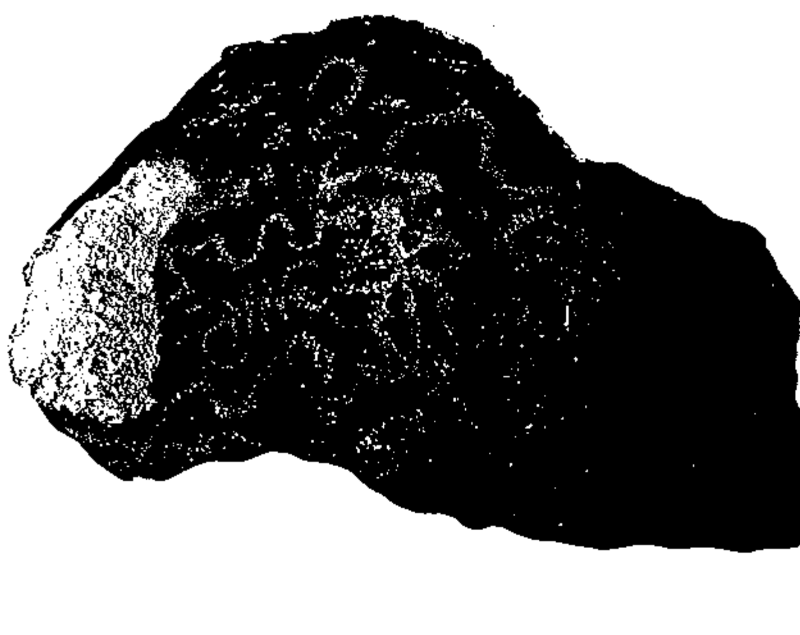
One of the site's most baffling features is a series of pebble drawings, perfectly preserved arrangements of pebbles into parallel rows and ovals on the ground. Anati suggests that their preservation may be the result of having been long covered with a sand dune.

Previously discovered cult sites in the Har Karkom area date mainly from the Chalcolithic period (4500-3100 B.C.) and Early Bronze Age (3150-2200 B.C.) and include standing stones, altars, stone platforms, circles, tumuli and a small temple. The area is also famous for its more than 35,000 examples of rock art. Recently, an especially remarkable discovery was added to the the rock-art inventory (below). Created by pecking with a pointed stone, this petroglyph shows a lizard, center, surrounded by five snakes and two scorpions. The petroglyph's images and location, above a pool of water, strongly recall a verse from the Book of Deuteronomy, as translated by Anati: "[God] led you through the great and terrible wilderness, with its serpents, poisonous lizards and scorpions . . . [and] brought you water out of the flinty rock . . . " (8:15).

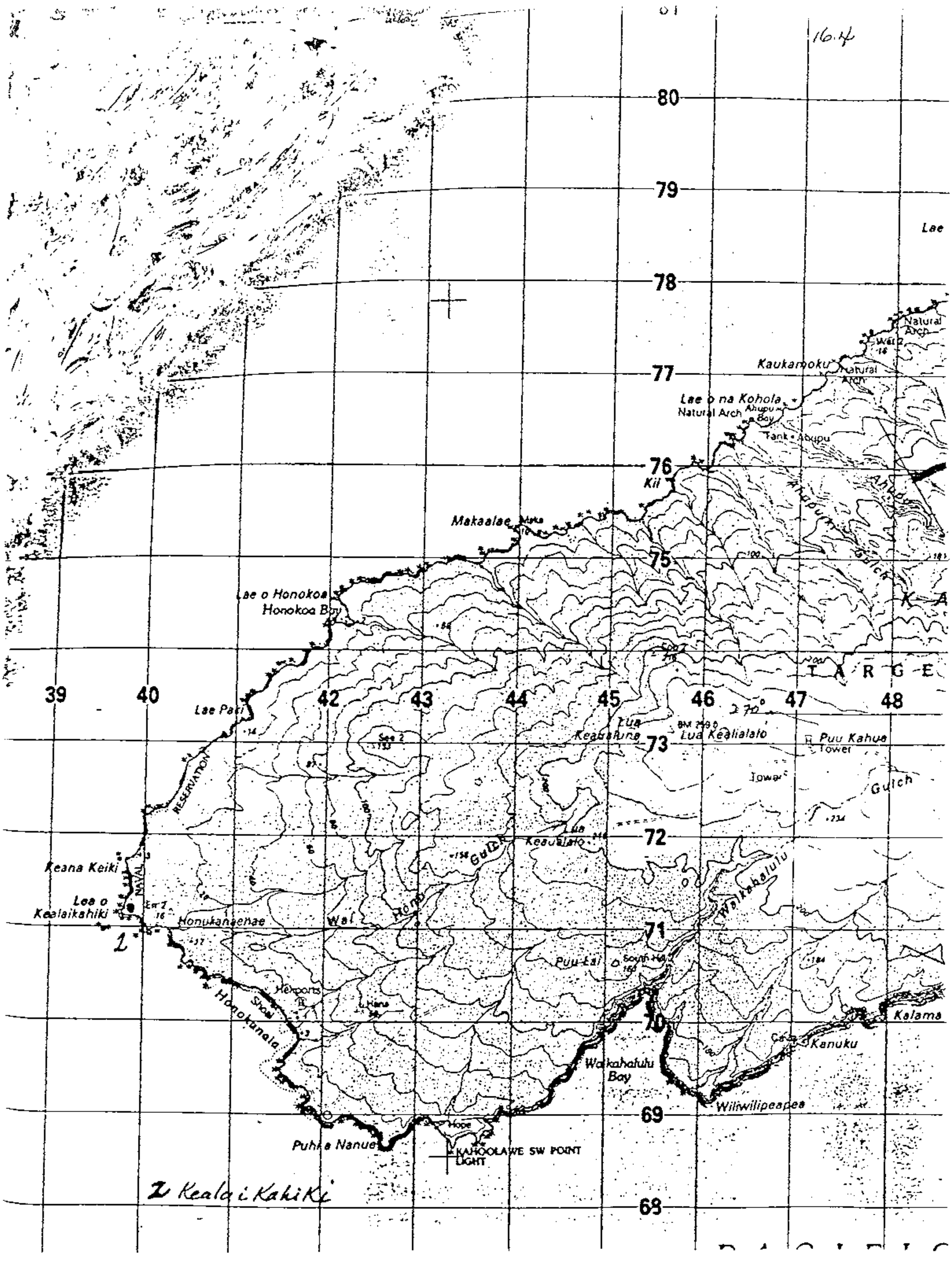
It was this abundance of cult sites, as well as discoveries such as the foregoing, that led Anati to conclude that Har Karkom is the Biblical Mt. Sinai. The paleolithic finds, however, suggest an astounding revision in our understanding of Mt. Sinai's significance. According to Anati, the finds indicate that "Har Karkom may have been a sacred mountain almost since the first appearance of modern humans." If so, we can better appreciate why Moses led the Israelites to the site.

Professor Anati will return to Har Karkom in 1993 (see dig listing, p. 37) and will lecture on his discoveries during a trip to the United States in February 1993 (see p. 21).

Photos are courtesy of Emmanuel Anati.



* See Emmanuel Anati, "Has Mt. Sinai Been Found?" BAR, July/August 1985; and the rejoinder by Israel Finkelstein, "Raider of the Lost Mountain," BAR, July/August 1988.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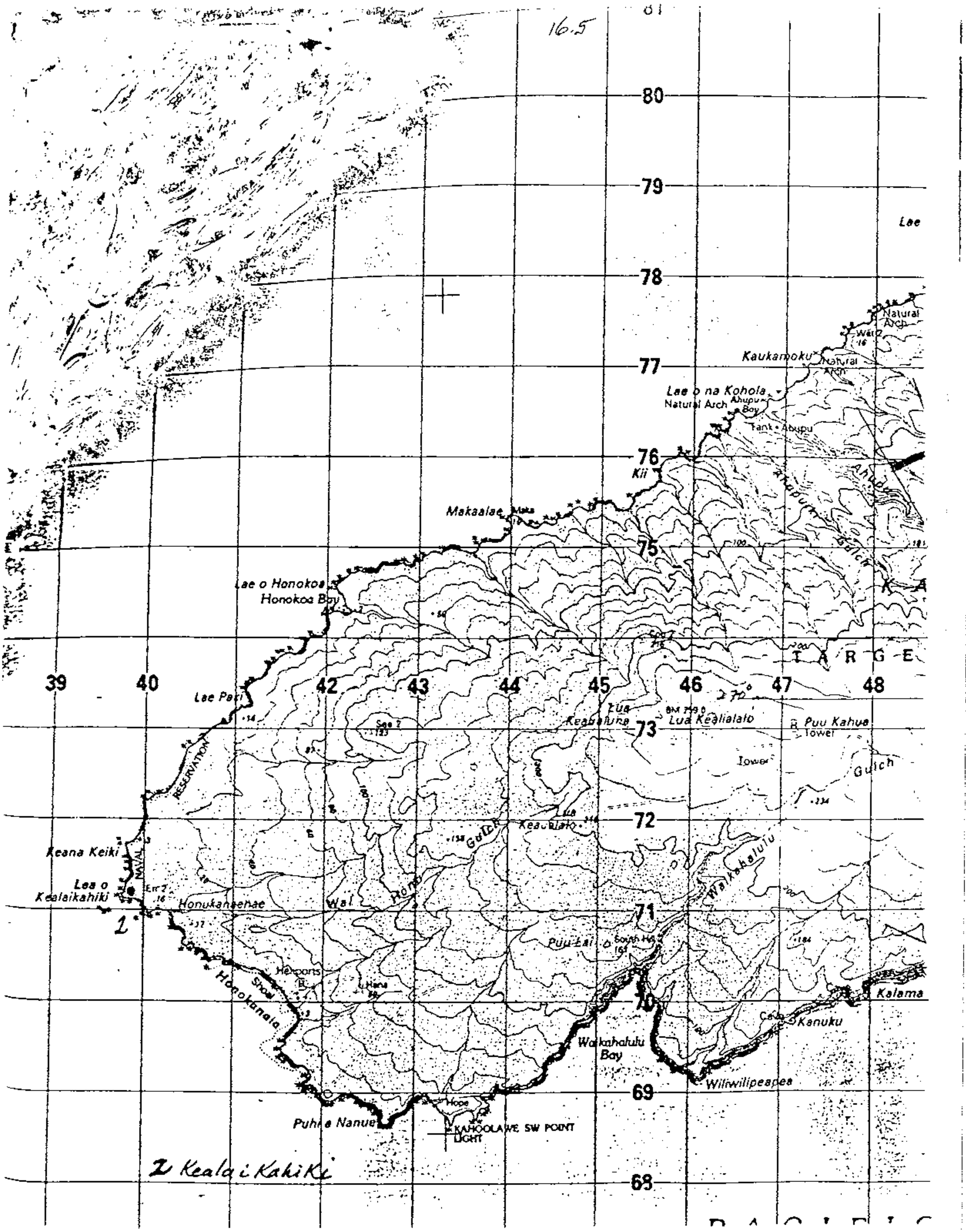
Waikahalulu Bay
69
Wiliwilipeapea
Puhi a Nanue
Hope
KAHOOLAWE SW POINT LIGHT
1 Kealaikahiki
68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47
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Lae
Natural Arch
Kaukamoku
Natural Arch
Lae o na Kohola
Natural Arch
Ahupu Bay
Tank
Abupu
Kii
Ahupu Gulch
Makaalae
Lae o Honokoa
Honokoa Bay
K A
T A R G E
Lae Pari
Lua Keahaluna
BM 299.0
Lua Kealialalo
Puu Kahua
Tower
Tower
Gulch
RESERVATION
NAVAL
Keana Keiki
Lae o Kealaikahiki
1
Honukanaenae
Wai
Hono Gulch
Keaualalo
Wakahalulu
Puu Lai
Honokanaia
Shoal
Heliports
Wakahalulu Bay
Kanuku
Kalama
Wiliwilipeapea
Puhi a Nanue
Hope
KAHOOLAWE SW POINT LIGHT
2 Keala i KahiKi

Rock formation, Ke-ala-i-Kahiki, facing due west, purported to be a compass stone formation.

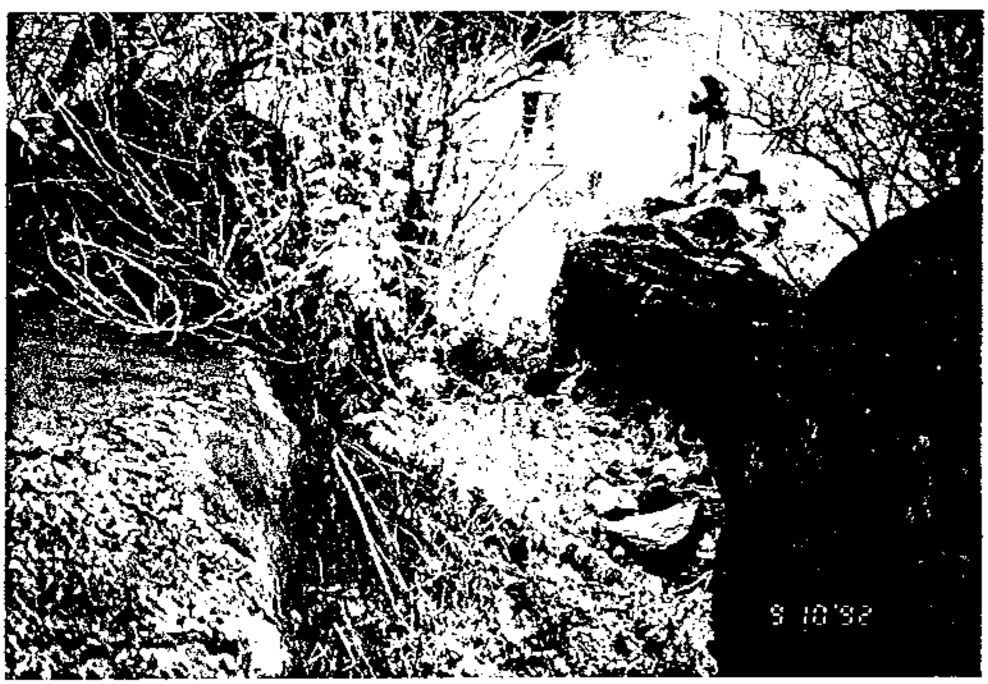
Shoreline, Ke-ala-i-Kahiki.

16.7

Ke-ala-i-Kahiki stone formation; westward orientation.

Ke-ala-i-Kahiki stone formation; eastward orientation.

Ke-ala-i-Kahiki, eastward orientation; views obstructed by overgrowth.



Ke-ala-i-Kahiki; kiawe obstruction to clear view of eastern orientation; would be in the way for sunrise, moonrise, etc., of any celestial body for early morning or evening observations. [Aki Sinoto; Hardy Spoehr]

ARCHAEOASTRONOMY OF KAHO'OLAWE I

Preliminary Report

Rubellite Kawena Johnson
April, 1992

THE POTENTIAL FOR PROBABLE ASTRONOMICAL ALIGNMENT, OR CELESTIAL ALIGNMENT, OF ARCHAEOLOGICAL SITES ON KAHO'OLAWE ISLAND, OR THE POTENTIAL FOR ARCHAEOASTRONOMY STUDY ON KAHO'OLAWE ISLAND.

A Preliminary Report/Working Paper on Field Study Conducted on Kaho'olawe at the Vernal Equinox (March 20-23), 1992.

Submitted by Rubellite K. Johnson, Consultant on Astroarchaeology Potential. Re Kaho'olawe.

Rubellite K. Johnson
Professor

I. Kaho'olawe's Place in Astroarchaeology/Archaeoastronomy

Services to be provided:

A. Literature Search - Conduct a literature search for reports, documents, articles, etc. relating to Kaho'olawe's relationship to astro-archaeology

B. Oral History Research - Contact knowledgeable individuals and record insights into related astro-archaeological resources on Kaho'olawe.

C. Fieldwork - Review and identify places which have astro-archaeological significance. A field trip to Kaho'olawe is anticipated.

D. Data Analysis - Analyze data as it relates to astro-archaeology on Kaho'olawe and make appropriate recommendations for historic preservation and future study.

E. Reports -

1. Submit monthly progress reports or as required on project's progress

2. Submit final report with all required data no later than June 30, 1992

3. Participate in professional discussion groups as required (at least two meetings of the Cultural/Historical Review Committee)

Research questions:

1. Are there astro-archaeological resources on Kaho'olawe?

2. Any recommendations for historic preservation?

Explanation:

This report briefs the committee on the exploratory results of a recent field trip to Kaho'olawe for the express purpose of assessing potential archaeoastronomical alignment of key sites prescribed by traditional reporting as sites having importance as to:

(a) relative importance to migration routes followed during discovery and migration periods of Hawaiians from the south and on interisland canoe trips, as in the Mo'ikeha/Kila/La'amaikahiki migration legend, Pele migration legend, per traditions reported in the several reports provided by the KCC (Reeve, Silva, etc.);

(b) "navigation" or "astronomy" training, or places where the kahuna set up places for observation, as for the purpose of learning and teaching navigation (per reports by Ashdown, Reeve, etc.);

(c) sites reported by native kupuna with traditions they may have heard from their own elders (i,e., Harry Mitchell re Keaweiki), or reported in translated Hawaiian newspaper articles (Kahaulelio, 1902, translated by Mary Kawena Puku'i in Hawaiian Ethnological Notes, Bishop Museum, in "Traditional Hawaiian Fishing Methods Practiced on the Island of Kaho'olawe");

(d) sites reported in the McCallister study on the archaeology of Kaho'olawe (Bishop Museum Bulletin, copy loaned to consultant by Archaeologist Rowland Reeve at Smuggler's Cove/Hanakanaea, Kaho'o-lawe during field trip);

The priority effort for this first field trip was to find any potential astroarchaeological significance to sites already reported in tradition as such, and to make a start <u>in situ.</u>

Regardless of the traditional reports, however, the effort is to come cold to the frontier of this type of endeavor in an organized fashion and to coordinate the cooperation of people in a sudden encounter both with the subject, the sites and the island themselves, and with each other, as it were, for the first time, none having any idea what needed doing, nor how we were all to go about doing it.

For this reason it was the consultant's request that a competent celestial navigator be brought to "interface" with the group from the military bastions because celestial navigation for the military has to be on target or it is ineffective. As it turned out the military provided us with a crack team:

(1) Lieutenant William Klein, instructor in navigation for the USN;

(2) Captain Milton Roth, Assistant Chief of Staff for Operations (on Kaho'olawe), and his assistant on Kaho'olawe,

(3) Lieutenant Vern Young;

(4) Senior Officer Edward Mrosczak.

Also assigned to us was Archaeologist Rowland Reeve, for the Ohana Kaho'olawe, who briefed us on our arrival and who accompanied us on the first day's trip to Moa'ulanui, Lua Makika, and who made available to the consultant all necessary information concerning sites reported by McCallister, including the bulletin itself so that we could make quick reference to those sites most available to us for the short three-day field trip. We were also privileged to have the Nature Conservancy group join us during this visit: Storrs Nelson and Terry Cabrera, in addition to

Archaeologist Pat McCoy (Pu'u Moiwi studies, with Aki Sinoto and Addison Makanani) and Archaeologist Michael Graves (Department of Anthropology).

Our archaeoastronomy team, however, was represented by:

(1) Rubellite K. Johnson, consultant in archaeoastronomy/ astroarchaeology (which are synonymous terms for the cooperation of two disciplines: archaeology and astronomy), but my credentials are really in ethnoastronomy, an adjunctive discipline emphasizing other specialities related to archaeoastronomy, such as linguistics, cultural anthropology, art history, architecture, mathematics, and folklore (i.e., the humanities component);

(2) Abraham Pi'ianaia (with 'Ilima Piianaia), member Review Board, Kaho'olawe Conveyance Commission; Department of Geography, UH-Manoa; experienced sailor in both contemporary and naked-eye celestial navigation on sailing ships/merchant ships/Hokule'a voyages;

(3) Lt. William Klein, USN celestial/aeronautical navigation instructor;

(4) Captain Milton Roth, experienced pilot; and

(5) Lt. Vern Young, who handled all of the logistics of transporting us to field sites with dispatch.

I submit to the commission my field notes as a diary of the expedition, because it is too soon to relate the field endeavor to true archaeoastronomy field techniques which would require plane table surveying of sites selected for close study. Our observations are based on preliminary use of standard nautical almanac data (Lt. William Klein) and use of planisphere approximations to stars which may be observed at latitude 25°N (rather than at the latitude of Pu'u Moa'ulanui, Kaho'olawe (latitude 20^{o} 34' N).

These notes provide commentary on sites visited, sites contemplated but not visited, personnel during each visit, days and times, experiments and observations effected and purpose of experiment/observation, and whether the sites visited and to which archaeoastronomic/navigation criteria /techniques were applied were also productive in assessing the potential for celestial alignment, and if so, then to what kind of celestial object or event, whether of stars, planets, moon or sun rise/set azimuth/declination (time/direction) for valid determination of any detected reason to believe that the traditional accounts oral or written offer substantial soundness regarding the use of any such site as designated.

My report at this time suggests that two sites visited may have and should be surveyed with archaeoastronomic potential in mind:

(1) Pu'u Moiwi, in relation to a parallel alignment at:

(2) Hakioawa (bluff/headland above the Hale o Lono site)

Pu'u Moa'ulanui, as the center for the island compass, is strategic for clear horizon views to all points of observation, and Pu'u Moa'ulaiki, which poses a problem in assessing if the tilt of its axis is directly related to the plane of the earth against the ecliptic, as of the Keaweiki Bell Rock (Aikupele), but which may be productive in other respects, such as probable alignment of Capella in Aurigae with its reciprocal at Procyon (NW to SE).

Nothing can be said now about Kealaikahiki as none of the compass stones were found by the team, or we may have been looking at them all of the time not knowing those were the ones. Even so, the stones are too surrounded by brush to be aligned clearly to anything celestial. In that context, we should not be faulted for spending the time being instructed in basic gnomonic techniques by military personnel whose understanding of sun dial or sun shadow knowledge helps to promote the archaeoastronomic agenda by what such strategies reveal about the earth and man in relation to the sun and time/space.

This leads me to this recommendation, following my and the group's experience on Kaho'olawe for the first time:

RECOMMENDATIONS

1. Once the archaeoastronomical potential has been roughly assessed for this period of time, between the vernal equinox and summer solstice, archaeological studies should:

(a) Map/chart the sites according to archaeoastronomic standards (e.g. Heggie, D.C. Archaeoastronomy in the Old World, Cambridge University Press, 1982; Aveni, Anthony F., Archaeoastronomy in the New World).

This will require someone with a knowledge of surveying + archaeology and who can hike up and down places where no trails have been broken for a long time. (I am too old for this sort of exercise). (Also too blind, I might add).

2. The island should be continued as a joint occupancy, and the U.S. military should not be forced out prematurely, because it has too much to offer in survival strategies, particularly in the

area of self and national defense, self and national/community/society survival and why that all goes hand-in-hand with self-reliant celestial navigation, as the first rule of thumb in survival is to know where you are at all times, and we are fast becoming if not already too dependent on mechanical gadgetry to do this for us, and unless we develop a more keen sense of not only who we are but where we are we may all wind up where we least wish to be in the future, particularly if we should lose our way in this world, as we see every-day how American youth are less able to decide what to do without constant supervision and help long after their teens.

My experience on Kaho'olawe has strengthened my observation that college students I teach now in the University of Hawaii Hawaiian language/culture classes, for all of their interest in survival of the Hawaiian culture, are even less and less capable in math and science, and while proud of the achievements of our ancestors in naked-eye astronomy and navigation are least willing to buckle down to the tough subjects and facts of human survival in the world of today and tomorrow. I saw younger people at the Kaho'olawe barracks with more strength of character and more capability to defend themselves and to save their countrymen, and having the willingness to also give their lives if necessary should they be called to war, boys and girls, that I came back to the university wondering how capable their counterparts on campus were willing or able to do the same if the roles were ever reversed.

I suggest that the island of Kaho'olawe be retained to expand joint training of our island youth in the mobility and scientific and character training which will be essential to their survival in a world ever hostile, and that the island be secured to initiate and to expand survival training for students who would volunteer to spend a week or two on Kaho'olawe learning more about the world and the universe than they could ever hope to know reading Ka Leo on the latest sexual-harassment gossip and legal action to take against the President of the University should he fail to uphold their rights.

How about the first institute for space studies, or a space center on Kaho'olawe, a joint endeavor between the agencies of government on both the state and federal levels to help our kids get a headstart in knowledge of the skies, taught by experts who know how to motivate people to uphold the best ideals for which this country has always stood its ground.

Wouldn't this be the best tribute to what Kaho'olawe may stand for, if it was once the island where the priests retired to reset their clocks, restimulate their connection to the sky above, and talk to God? That would be the ultimate reconnection to the umbilical cord stretched between earth and sky and to which we fix our center. Instead of kicking out the forces, why not joint forces? The military has protected us, given their lives, ever since I can remember them in their pup tents next to our house in Lawai, Kauai. They all died in the Pacific. They're under the water at Pearl Harbor. The slabs are in rows in Punchbowl Crater. I say let them be. They have much to teach us, and we have much to learn, yet, from them.

A Preliminary Report and Working Paper: "Archaeoastronomical Potential of Traditional Sites on Kaho'olawe," March 1992 Equinox Report by:

Rubellite Kawena Johnson,
Consultant
Kaho'olawe Conveyance Commission
April 3, 1992

[Typed manuscript]

Kaho'olawe Conveyance Commission: Archaeoastronomy/Astroarchaeology
Project for Kaho'olawe

Tentative Program/Suggested Approach for Consideration

Re: Preliminary meeting: Hardy Spoehr, KCC
R. Johnson, UH
Lt. Vern Young, Navy
Rowland Reeve, Archaeologist, KPO

Thursday, March 5, 1991/noon-afternoon meeting
Hawaii Maritime Center, Honolulu

A. What is necessary to determine the importance of Kaho'olawe for archaeoastronomy/astroarchaeological research

1. What is its strategic importance to navigation in the islands?

(a) with respect to all points of observation?

(1) the adjacent islands, channels
(2) observation to the west (no obstruction)
east
north
south

(b) what advantage to navigation to other islands in Polynesia?

2. What basic astronomy/archaeology factors would be expected to exist for the benefit of navigational information?

(a) Kaho'olawe exists outside the normal cruising range in between channels, so:

(1) It would be within a range of reference relative to Maui, Lana'i, and Kaho'olawe, therefore:

(2) It should be viewed from those islands:

(a) shoreline/mountaintop reference points/heiaus on Maui, Lana'i, Moloka'i

(b) the west sie of Kaho'olawe (like all other western sides of the islands provides access to star setting(s) (and sun/moon, etc.) azimuths westward (open sky/horizon)

3. Strategic importance as a compass center, probably Pu'u Moa'ula-iki [Site #202], Pu'u Moa-'ula-nui

(c) the east side would see celestial bodies (sun, moon, stars, planets, etc.) against Maui, therefore which outstanding positions (mountains, etc.) on Maui are important reference points?

(c) the meridian/longitude and latitude determination of Moa'ula Point on Kaho'olawe, as one of the high points of reference/position on the island itself as in situ observation point:

B. How can Moa'ula Point on Kaho'olawe Island serve to give some answers to (c) under (2) above?

1. Sun observations: to east/west at equinoxes/solstices to determine latitude:

(a) mark the direction of the sun shadow on the equinox (vernal/autumnal) to azimuth of rising by a sun shadow pole or stone at rising or setting on that day.

March 19, 1992 Vernal equinox

(b) mark the direction of the sun shadow on the solstice (summer/winter) to azimuth of rising or setting

June 19-22 (?) 1992 Summer solstice

(b) these shadow markings would give 1/2 the amplitude of the sun at the latitude of Moa'ula, and an angle drawn at right angles from the equinoctial side to the pole (south or north), would find the direction north/south to the meridian = longitudinal axis

2. Star observations: for meridian/longitude of Moa'ula Point

(a) determine which polar stars north and south line up on the meridian of Moa'ula at different hour circles from sundown (18th or 20th, including the 19th) on March 19, 1992 (Big Dipper Clock approach)

(b) plot azimuths (star risings/settings) for first magnitude stars (etc.) on a star chart for the nights of observation.

C. Tentative Itinerary

1. Field excursion: March 20-23, 1992 time selected to coincide with the vernal equinox.

3/20: ETD 7:25 a.m. Pearl Harbor (Ford Island Ferry)
ETA 9:45 a.m. Kaho'olawe; Hanakanae'a military base camp

3:00-5:00 p.m. Pu'u Mo'iwi
Pu'u Moa'ulanui/Lua Makika

3/21: Stops: Kealialalo
Seagull Observation Pt.
Wiliwili grass replanting area
Hakioawa

3/22 Kealaikahiki
Sailor's Cap

3/23 Return Honolulu

D. Sites Selected [3/20-23, 1992]

[x shows if site was visited]

1. _____ Shrine Site #108 (upright slabs; sun-connected?)

2. __x__ Site 348A, Hakioawa: Ku'ula fishing shrine/high bluff [Visited 3/22/92]

3. __x__ Site 358, Hakioawa: Hale o Lono/southern ridge [Visited 3/22/92]

4. _____ Site 560, Hakioawa: Hale o Papa/ridge opposite Hale o Lono

5. __x__ Site ___, Pu'u Moa'ulanui; tradition of La'amaikahiki, Tahiti/Hawaii migration [Visited 3/20 and 3/23]

6. _____ Site____, Lae o Ka 'Ule, north point/cape of Kanapou Bay; Story of Rata/Nganahoa

7. _____ Site ___, Ka-lua-o-Kamohoali'i; tradition of Kamohoali'i, Pele migration/Borabora to Hawaii

8. __x__ Site ___, Kealaikahiki, east cape; reported site of a stone

9. _____ Site ___, Pu'u Moa'ulaiki; tradition of La'amaikahiki, Tahiti/Hawaii migration [Visited 3/23]

10. _____ Keanapou Bay

11. _____ Kamohio Bay

12. __x__ Site ___, Pu'u Mo'iwi adze-making place [Visited 3/21/92]

D. Personnel [3/20/92 Vernal Equinox day]

(a) In camp/Smuggler's Cove, ..anakanae'a
Team:

1. R. Kawena Johnson, University of Hawaii, Dept. of Indo-Pacific Languages; investigator (ethnoastronomy)

2. Abraham Pi'ianaia, University of Hawaii, Dept. of Geography; geographer, celestial navigator, naked-eye astronomy

3. 'Ilima Pi'ianaia, Administrator (land management and international protocol for the State of Hawaii)

4. Lt. William Klein, USN Celestial Navigation Instructor, Fleet Training Group/43, Pearl Harbor, H.I. 96830-7600

5. Rowland Reeve, Kaho'olawe 'Ohana, archaeologist; field guide

(a) Field trip to Moa'ulanui with Nature Conservancy Group: Storrs Olson, Terry Cabrera; Pat McCoy, archaeologist, Pu'u Mo'iwi.

E. Field Excursions

(a) Selected primary sites (visited):

[Friday 3/20]:	1. Pu'u Moa'ulanui
[Saturday 3/21]:	2. Kealaikahiki 3. Pu'u Mo'iwi
[Sunday 3/22]:	4. Hakioawa
[Monday 3/23]:	5. Moa'ulaiki

[D.b.] Personnel: 3/23/92: Invited by Captain Milton Roth and Lt. Vern Young to visit this site.

(b) Selected sites not visited (although planned):

(1) Site 108 [McAllister] shrine/upright slabs
(2) Site 360 Hale o Papa, Hakioawa
(3) Lae o Ka Ule, No. Pt. of Kanapou Bay
(4) Ka-lua-o-Kamohoali'i
(5) Keanapou Bay
(6) Kamohio Bay

F. Program

(1) Friday 3/20/92 Observations/field notes:

Weather sunny at Smuggler's Cove [Hana-ka-nae'a, 'Bay-of-the-Porpoise']

(a) Took sun-dial reading to North at barracks

(1) Equipment: Solar time piece with base + gnomon

(b) Lt. Wm. Klein reported from almanac, that noon on the equinox day at latitude of Kaho'olawe:

(1) 12:33 +26 minutes

(2) Noon sun shadow indicates not only time as 12 o'clock but direction NOrth (although noon is actually at 12:59 a.m.

(2) 18 hours 37 minutes will be sunset

(3) 18 hours 59 minutes will be civil twilight

(c) Wind direction: NE trades

(d) Actual observation: 12:33 a.m. [349° compass corrects 11° magnetic north to true north]

(e) Altitude of sun at 80°

(2) Friday 3/20/92 (continued):

(a) Plan - to visit Moa'ulanui as highest point of island in order to establishe a compass center of reference to horizon positions [azimuth] of rising celestial bodies and setting azimuth reciprocal, and:

(b) To relate Moa'ula compass center axis (longitude/latitude/zenith/local meridian) to visbile island-to-island points/bearings (as to extremes, i.e., capes, points, points farthest east/west);

(c) To obtain from that locus the meridian (i.e., local meridian, kaupoku o ka hale o ke akua 'ridge-pole of the house of god'), or piko o ka honua ('navel-of-the-earth', locus of observation, i.e., center of the horizon circle (kumuhonua), i.e., the visible horizon, so as to determine stars at their point of rising (azimuth) from 0°N to 180°S from Moa'ula-nui;

(d) To note other rising and setting positions of prominent stars (first/second magnitude) at the time of the vernal equinox (vernal/spring, March):

[Note: Weather did not permit, as squalls began to threaten after 3:00 p.m. (when we were at Lua Makika), clouding visibility, and it rained profusely after 8:00 p.m., clouding all visiblity at midnight, clearing at about

3:00-4:00 a.m. 3/21/92

d.1. Observations:

1. Rigel in Orion 34°15' setting at midnight 261°W
2. Betelgeuse in Orion above horizon 15°, setting at midnight 271°W
3. Dubhe in Big Dipper is on meridian 12:00 midnight
4. Acrux (Southern Cross) 170° almost due south at midnight
5. Canopus on meridian at 9:00 p.m.

e. At Moa'ulanui (clouded in) 2:50 p.m. (elevation 1477 ft)

(1) Bearings to visible islands/landmarks taken by Opti-Compass (A. Piianaia):

(a) to Lanai: 283° NW
310° NW

(b) to Maui: 075° NE
330° NW

(1) Pu'u Ola'i: 045° N

(2) Wailuku: 009°-010°N

(3) Molokini 033° NE

(c) to Hawaii:

(1) Maunakea: 115° SE

(2) Maunaloa: 105° SE

(3) Hualalai: 128° SE

(2) Indicates that these are all visible from Moa'ulanui and are within its visible horizon compass; on clear days this would extend to Moloka'i and O'ahu

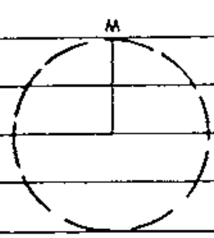
f. Lt. Wm. Klein provided his notes for March 20-21, at to prominent stars of these nights of the year.

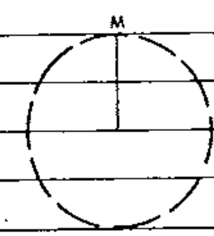
← 6. KAHO'OLAWE 20 THRU 22 MARCH 92

NAVIGATION WORKBOOK
OPNAV 3530/1 (Rev. 7-74)

20°34'N 156°34W

DATE/DR POSIT	DATE/DR POSIT	DATE/DR POSIT	DATE/DR POSIT	DATE/DR POSIT
20 MARCH 92	20 MARCH 1992			
LAN ☉	LHA	097		
1207	BODY"	HC	ZN	
+26				
1233	POLARIS	20 34	000	
	"HOKU PAA"			
	DUBHE	27 32	030	
SUNSET	REGULUS	36 47	090	
1811				
+ 26	PROCYON	65 (RUDE)	138	
1837	"TAULUA"			
	SIRIUS	53 04	173	
	"KA HOKU HOOKELEWA"			
CIVIL TWILIGHT	RIGEL	56 26	215	
1833				
+ 26	ALDEBARAN	63 03	267	
1859 W	"KANUKU OKAPUAHI KAOMA'AIKU"			
210459Z	CAPELLA	60 30	336	
238 55.6	JUPITER	26 (RUDE)	092	
14 47.4	"KAAWELA"			
253 43.0	ARCTURUS	—	—	
156 34 0W				
97 0°				
MOON RISE				
2100				





BILL KLEIN QMC
FLEET TRAINING GROUP
(FORD IS.)
PEARL HARBOR, HI 96864

WORK 472-8881 EXT 356/7/8
HOME 455-8306

NAVIGATION WORKBOOK
OPNAV 3530/1 (Rev. 7-74)

21 MAR AM — KAHO'ALAWE 6.2 — 20° 34'N - 156° 34 W

DATE/OR POSIT	DATE/OR POSIT	DATE/OR POSIT	DATE/OR POSIT	DATE/OR POSIT
21 MAR	21 MAR	AM		
CIVIL TWILIGHT	BODY	HC	ZN	
0542				
+ 26	POLARIS	20 34	000	
0608.4	"HOKU PAA"			
SUNRISE -	DENEB ◇	48 23	043	
0604				
+ 26	ENIF	35 15	092	
0630.4				
	NUNKI ◇	41 50	163	
LAN				
1207	ANTARES	38 35	206	
26				
1233	ARCTURUS ◇	37 19	279	
21 1630.4	ALKAID	32 22	317	
59 25.2				
7 37.2	KOCHAB	30 10	347	
67 02.4				
427 02.4	VENUS	014	106	
156 34.0	"HOKULOA"			
270 28.4	MARS	22	118	
	"HOKUULA"			
	SATURN	27	128	
	HOLOHOLOPINAAU			
MOONSET				
0825.6				

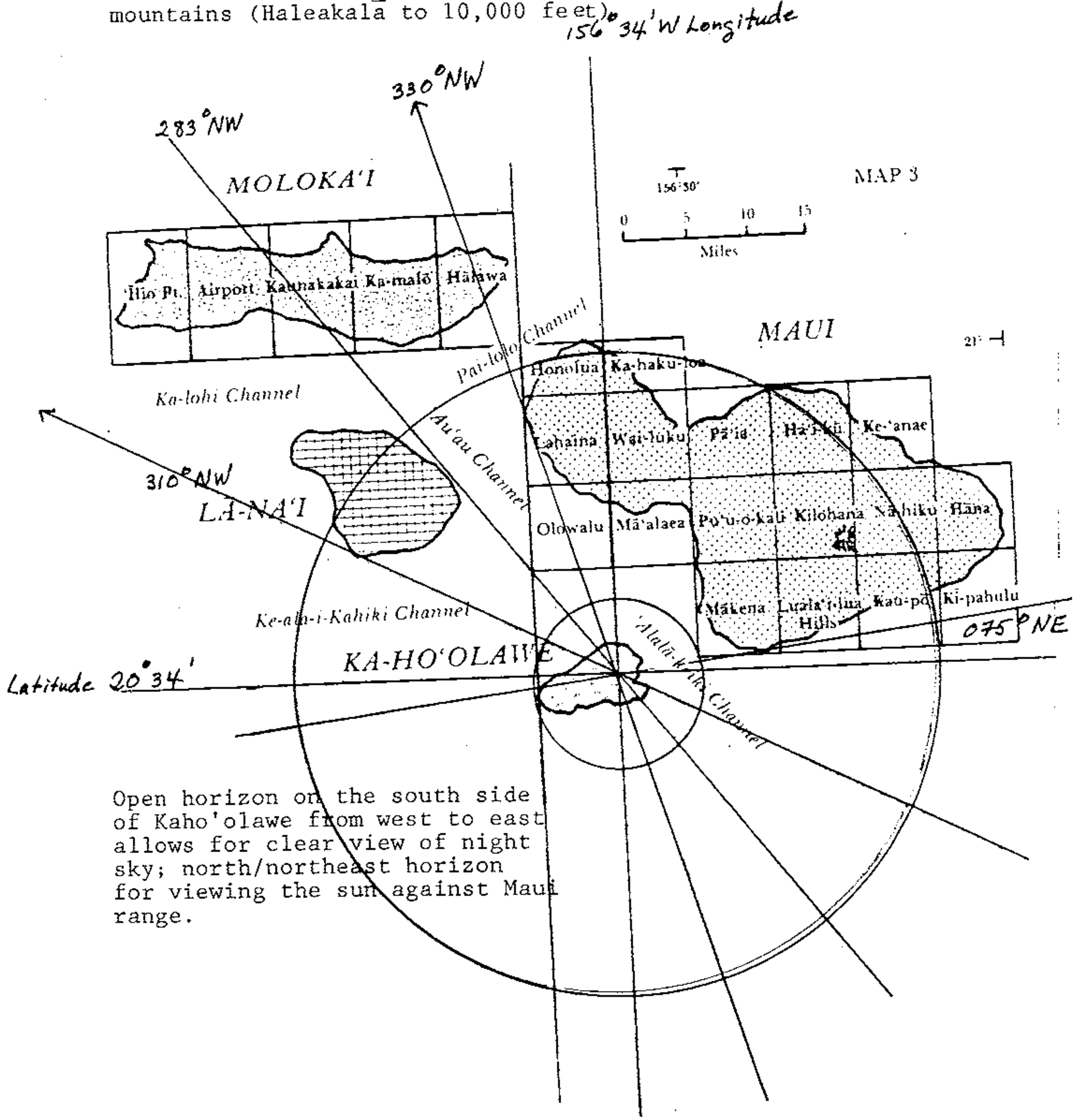
M M M M M

USN, NAVIGATOR

6-3

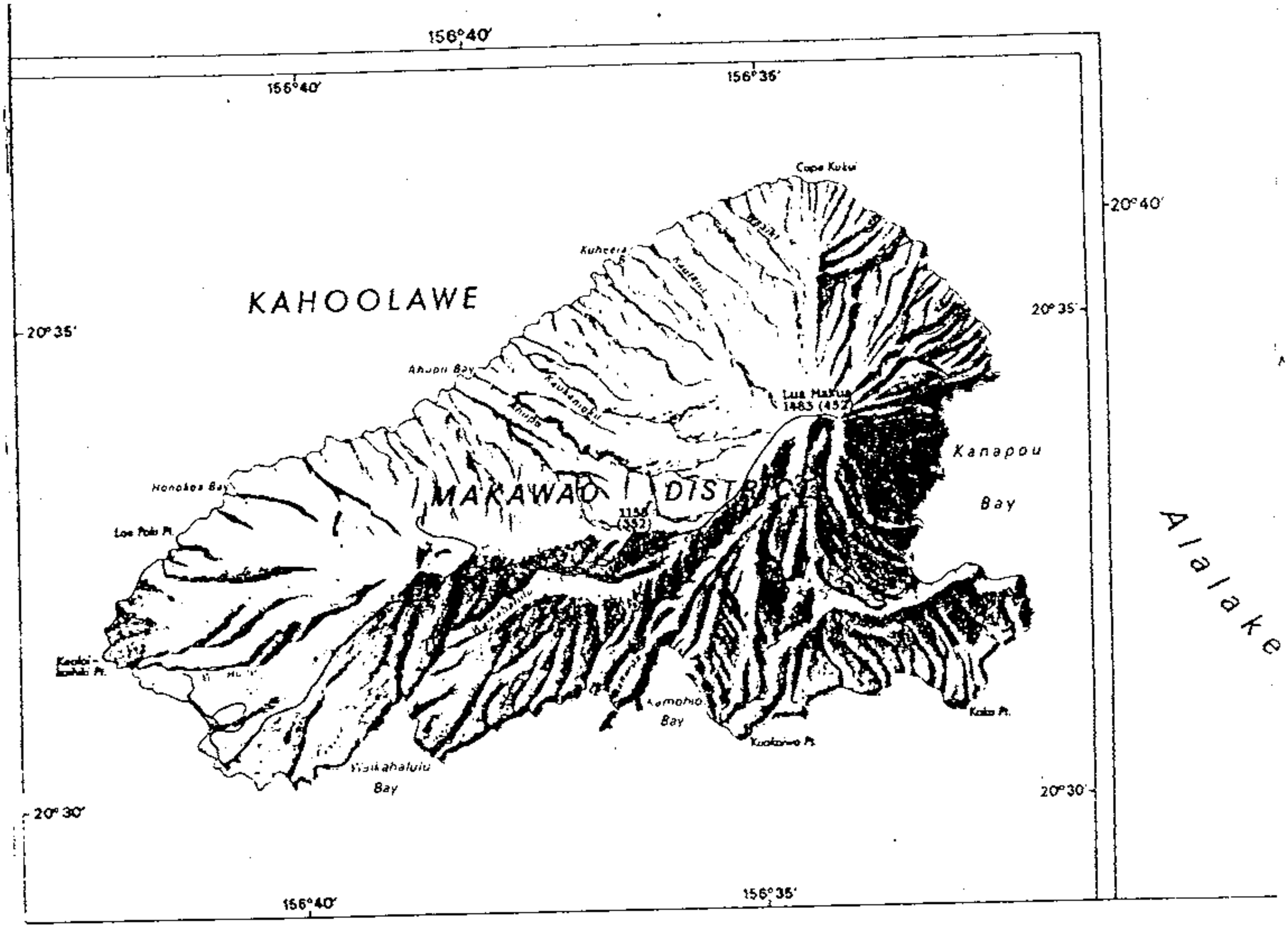
Bearings to Lana'i and Maui taken by Opti-Compass between visible landmarks within the compass circle of the horizon from Moa'ulanui/Lua Makika, Kaho'olawe. [*Note: bearings by magnetic compass].

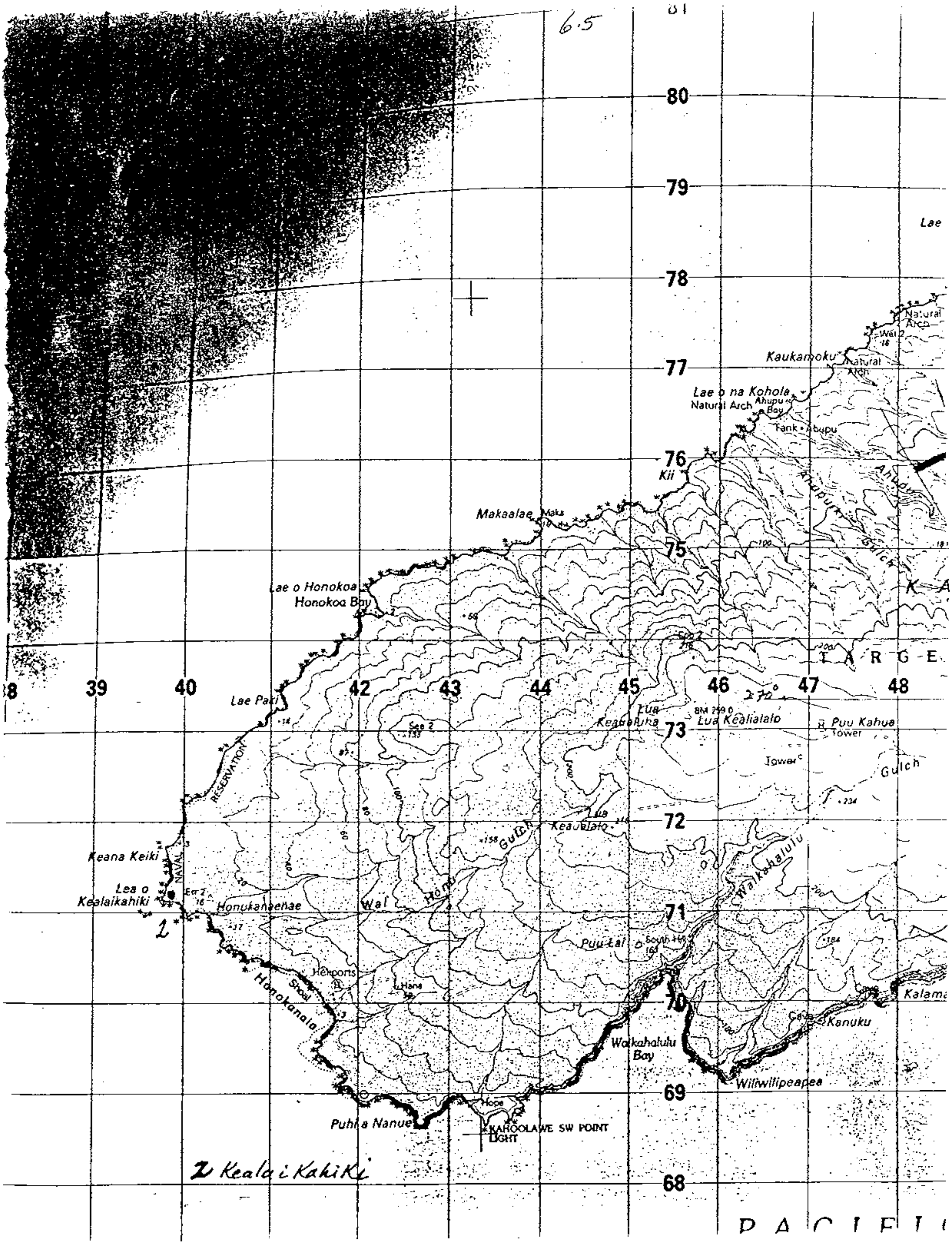
Visible horizon from Lana'i (bearing 310° NW to Kaunolu, to East Maui 075° NE; 283° NE from Lana'i to 330° NW East Maui open horizon and across the isthmus of Maui between Wailuku and Makawao (north); view from to N to NE bounded by West Maui mountains (Haleakalā to 10,000 feet).



Open horizon on the south side of Kaho'olawe from west to east allows for clear view of night sky; north/northeast horizon for viewing the sun against Maui range.

6.4


156°40'
156°40'
156°35'
20°40'
20°35'
20°35'
20°30'
20°30'
KAHOOLAWE
MAKAWAO
Cape Kukui
Ahupu Bay
Kanapou
Bay
Honokoa Bay
Kamohio
Bay
Bay
156°40'
156°35'
Alalake



6.5
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45
46
47
48
Lae
Natural Arch
Wai 2
Kaukamoku
Natural Arch
Lae o na Kohola
Natural Arch
Ahupu Bay
Tank
Ahupu
Kii
Ahupu Gulch
Makaalae
Lae o Honokoa
Honokoa Bay
T A R G E
Lae Paki
270°
Lua Keaalaluha
BM 259.0
Lua Kealialalo
Puu Kahua
Tower
Tower
Gulch
RESERVATION
Keana Keiki
NAVAL
Lea o Kealaikahiki
Honukanaenae
Wai Hono
Gulch
Keaualalo
Wakahalulu
Puu Lai
Heliports
Shoal
Honokanaia
Walkahalulu Bay
Cave
Kanuku
Kalama
Wiliwilipeapea
Hope
Puhi a Nanue
KAHOOLAWE SW POINT LIGHT
1
2 Keala i Kahiki
P A C I F I

3. Saturday, March 21, 1992 Exhibits:

(a) Escorted to Ke-ala-i-Kahiki by:

(1) Captain Milton Roth
Asst. Chief of Staff for Operations and Plans (N-3)
Commander, Naval Base, Pearl Harbor

(2) Lt. Vern Young, Office-in-Charge on Kaho'olawe assigned to our group

(b) Team: R. Johnson   Lt. William Klein
A. Pi'ianaia
I. Pi'ianaia

(c) Objective: to locate compass stones described in reports [Reeve et. al.]

(1) Failed to locate compass stones; probably covered by kiawe and other brush; difficult to orient if overgrown.

(d) Experiment with upright stone as a gnomon:

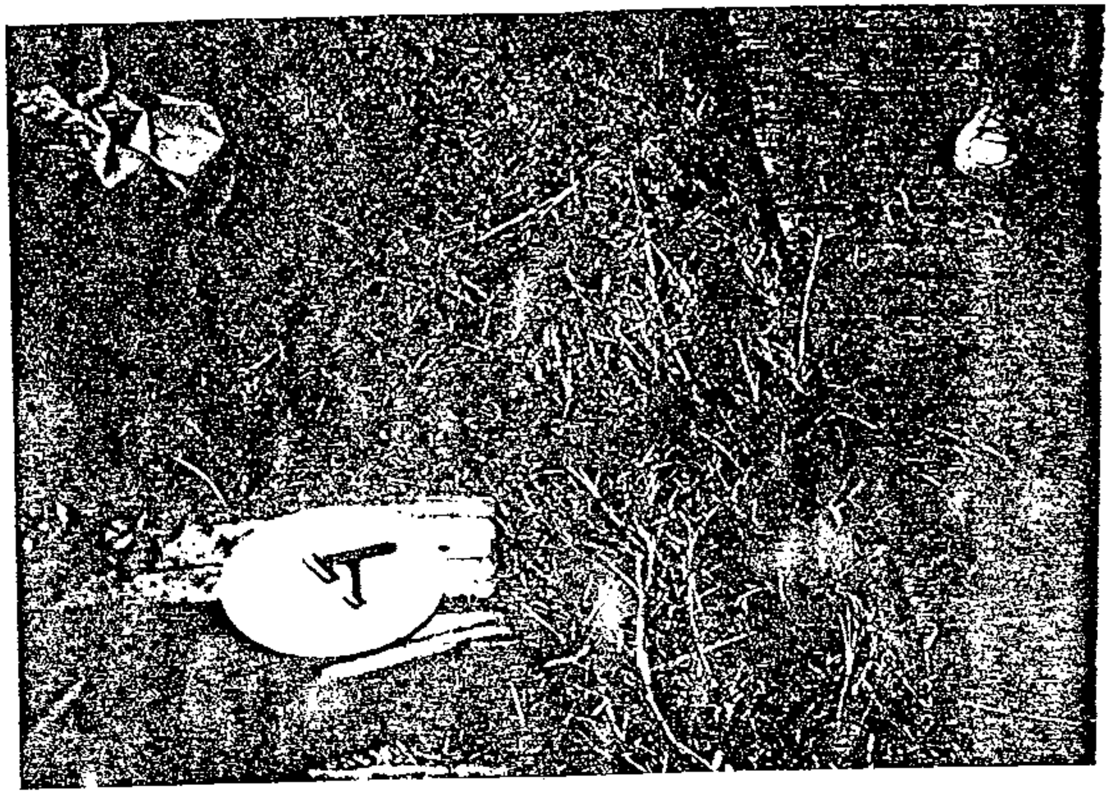
(1) Sun bearing 097° SE by shadow line

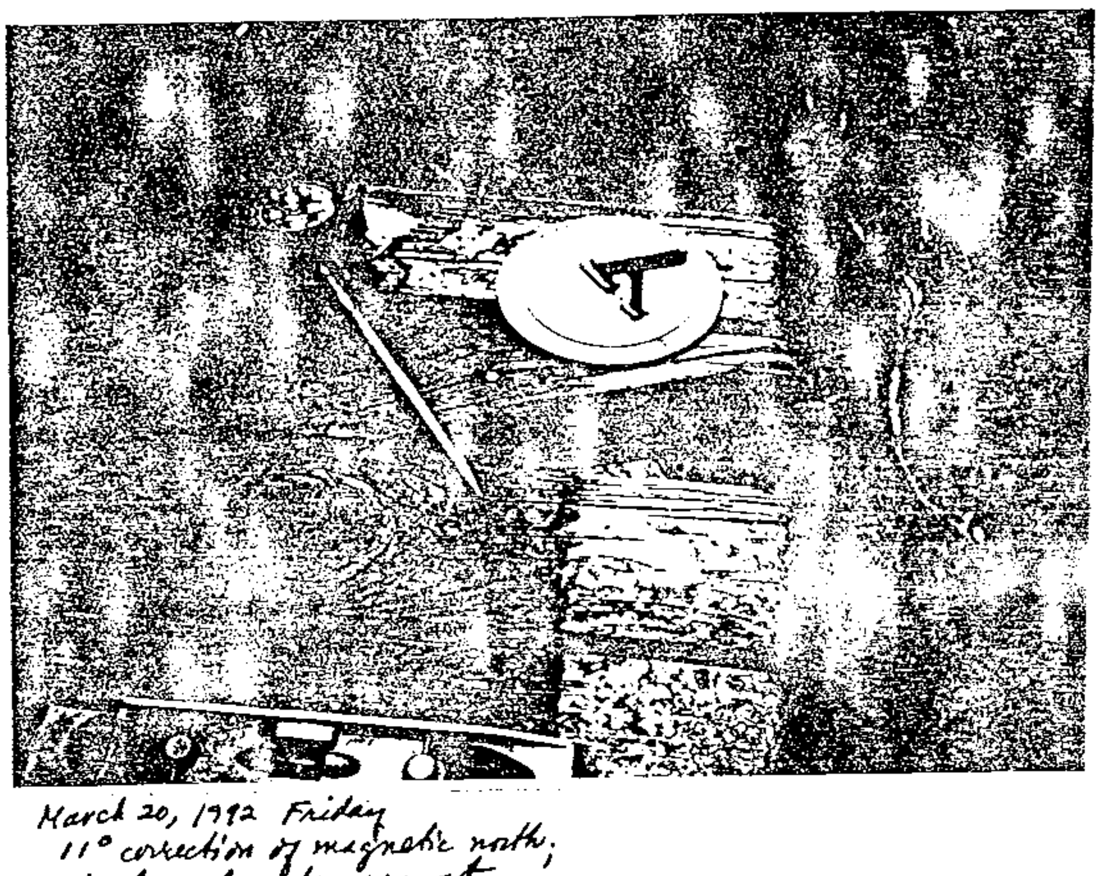
(a) Attempted by A. Piianaia and R. Johnson with small upright (i.e., Kāne stone)

(b) Explained by Capt. Roth with regard to sun shadows north of equator:

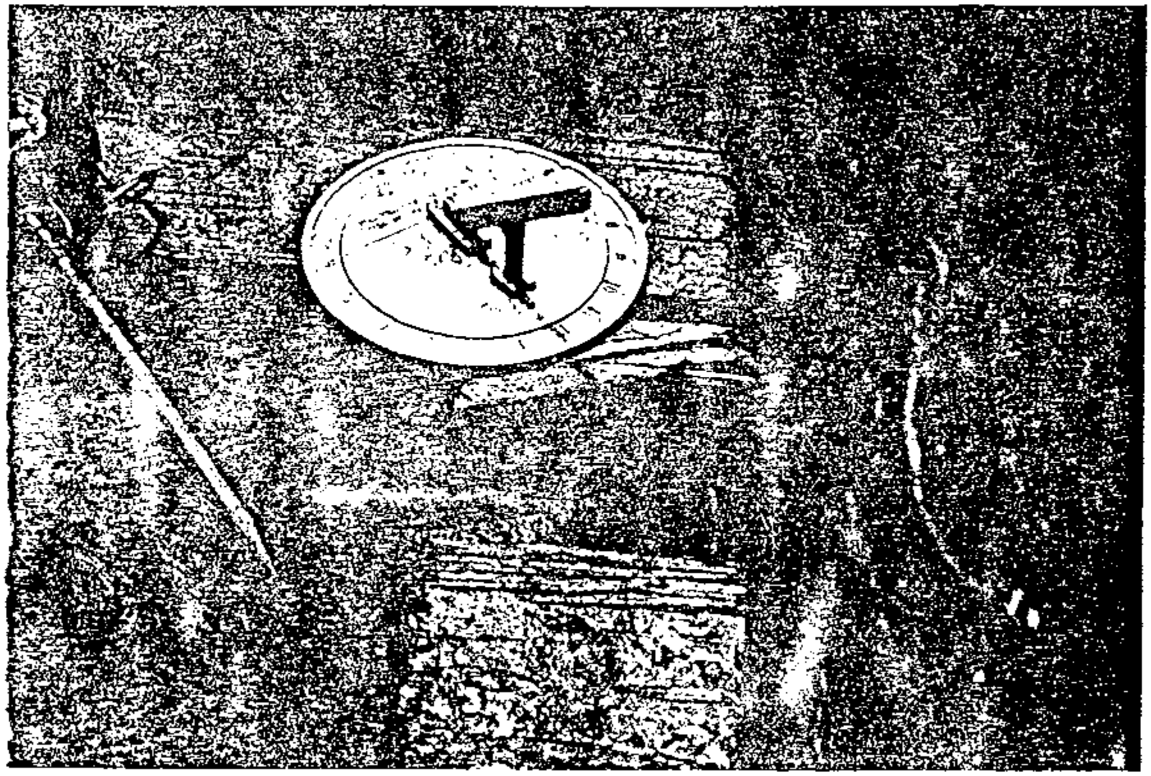
(1) Coral model of base stone with gnomon (stalk of grass) upright and movement shortening of shadow at noon, with direction to north

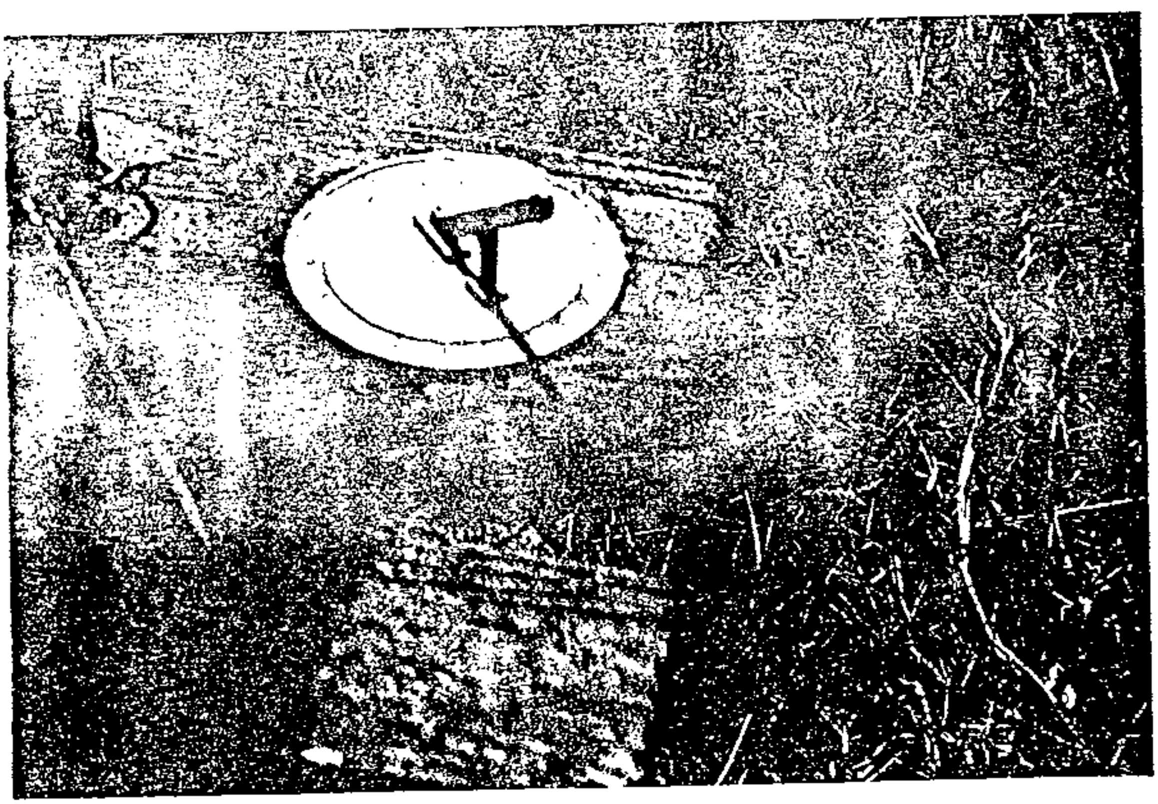
8.1

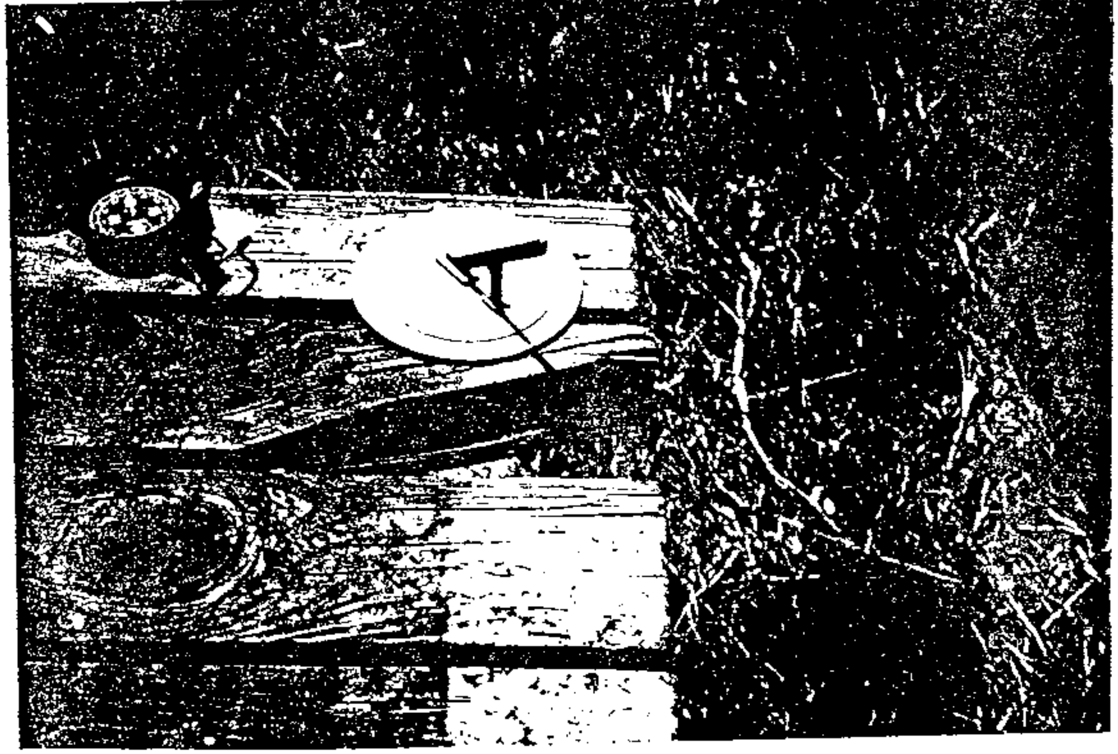


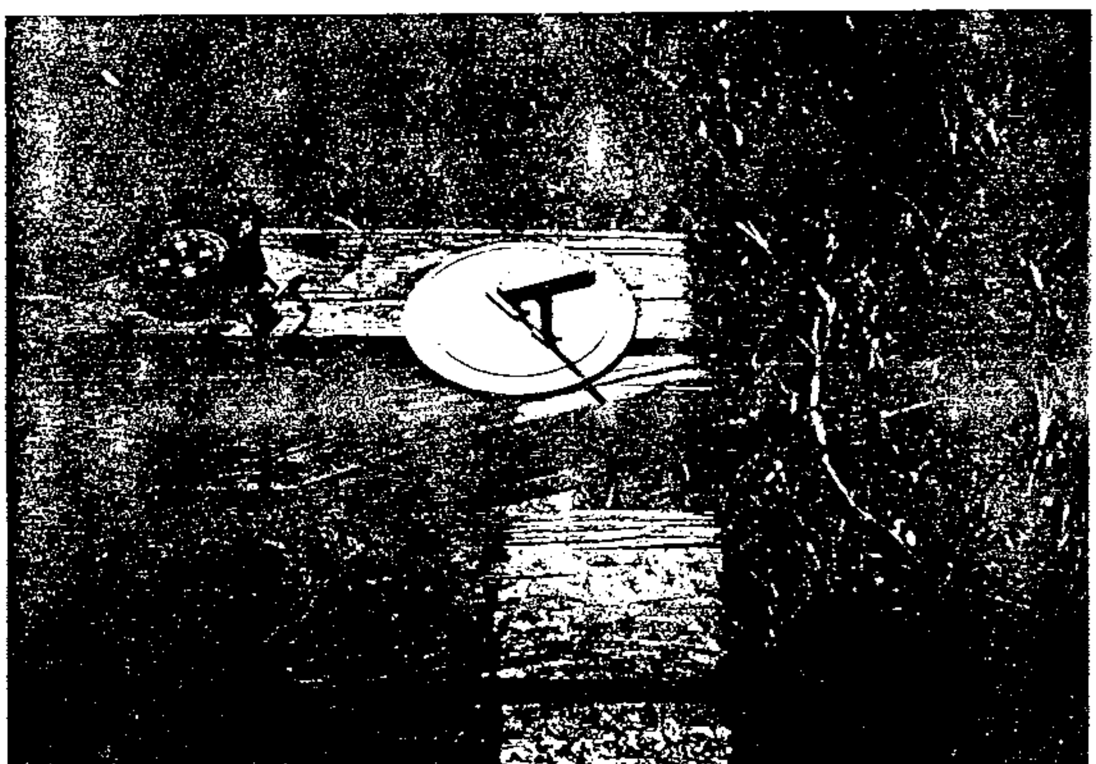


March 20, 1992 Friday
11° correction of magnetic north;
shadow close to noon at
equinox









Shadow about 12:40 noon
bears true north, Smugglers
Cove March 20, 1992.

Keala i Kahiki: March 21, 1992
(above) looking southwest
(below) looking northeast, toward West Maui, Moloka'i

8.5

Kealaikahiki: Shadow at about 11:00a.m; Capt. Roth instructs group on gnomonics using coral sundial as tool.

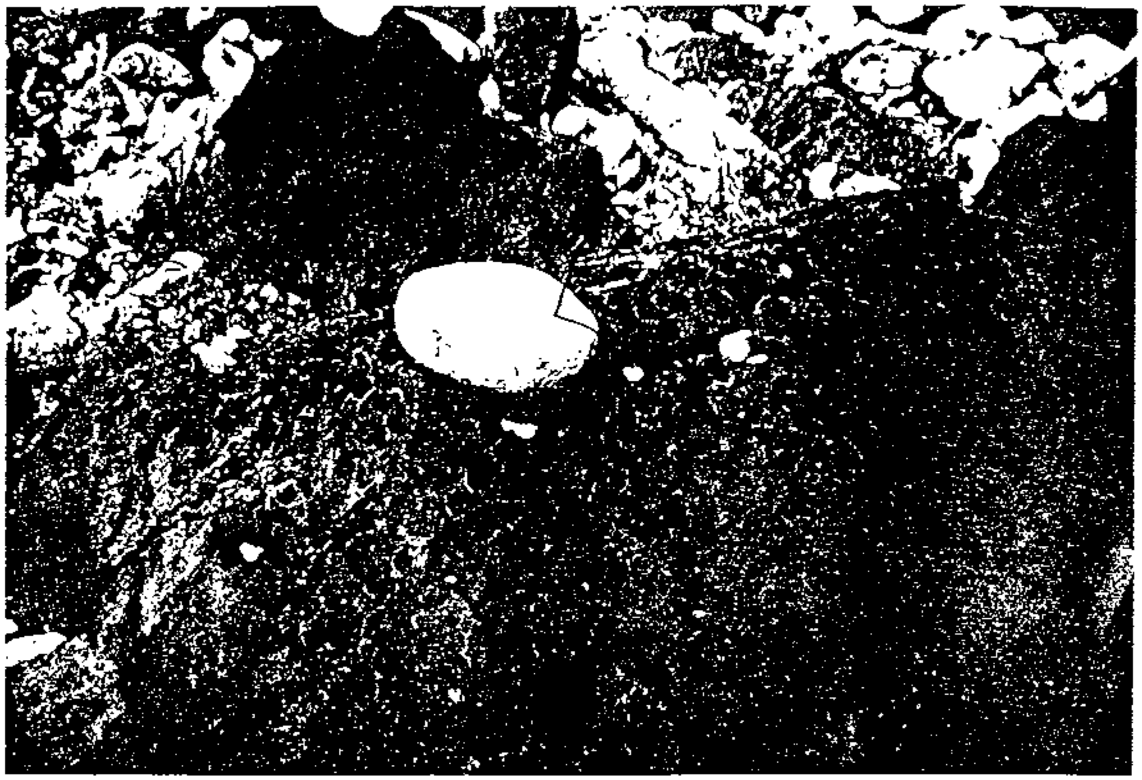
CAPT Milton D. Roth, Jr, USN
"MIT"
Asst. Chief of Staff for Operations and Plans (N-3)
Commander, Naval Base, Pearl Harbor

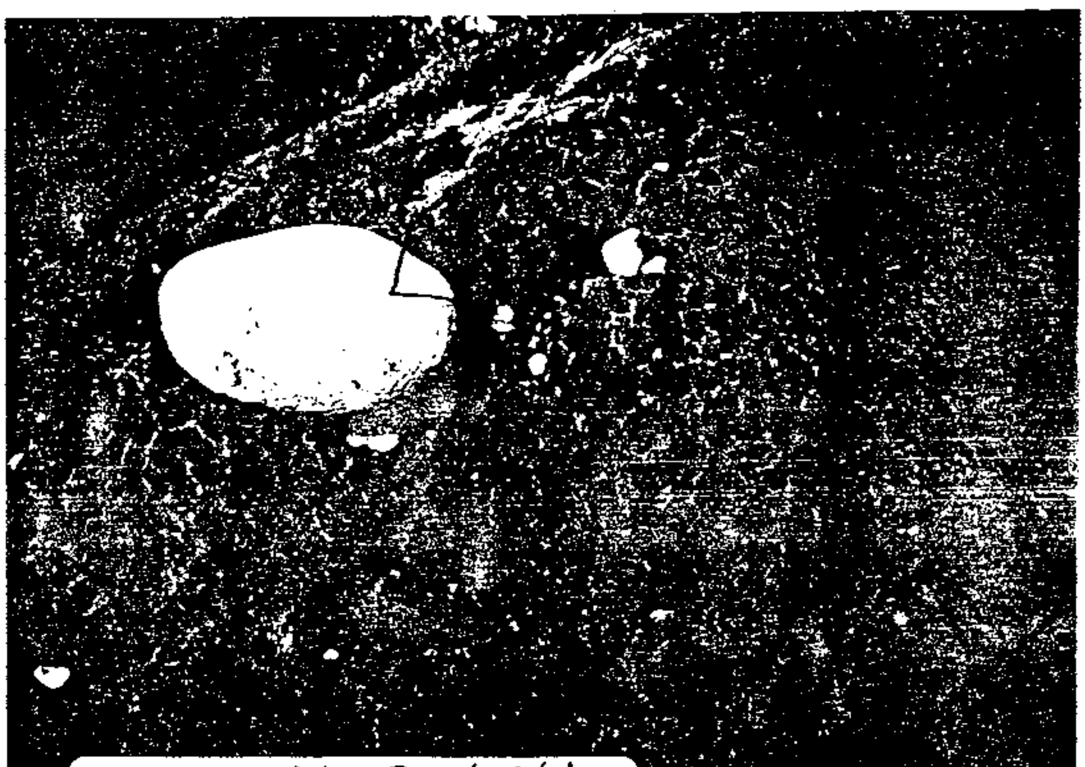
Pearl Harbor
Hawaii 96860

808-471-308
FAX 471-955

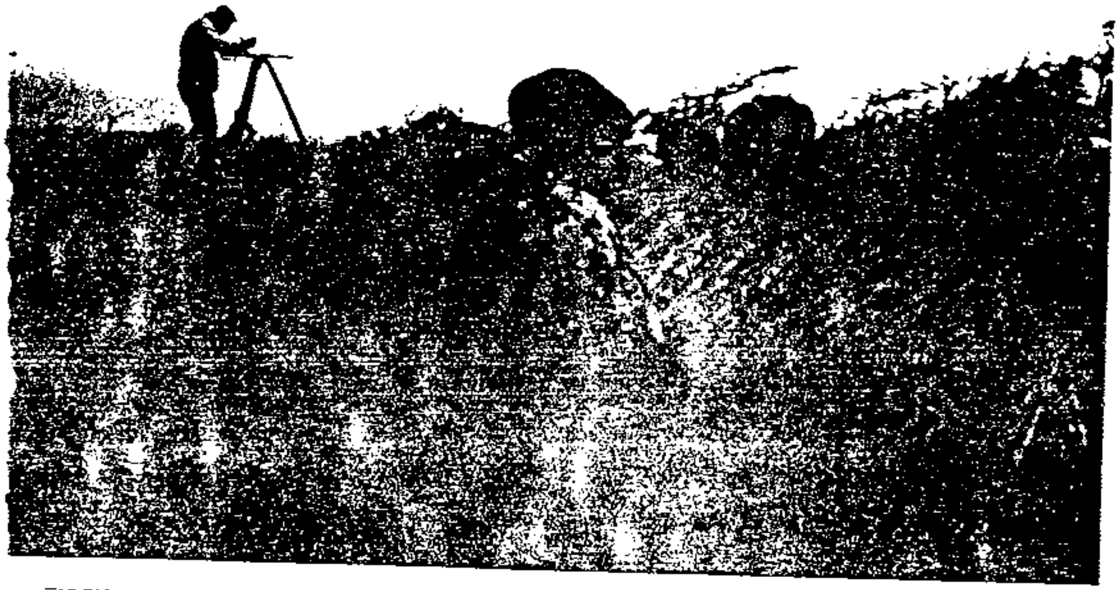
Coral sun-dial made level; shadow before noon approaches north; vernal equinox, day after.

8.7





Shadow indicates direction north; does not give latitude or position; rather, time; North at noon.



Puu Moiwi March 21, 1992
(Above) From central mound stone looking to natural boulder bearing about 162°SW, or Canopus/So. Cross azimuth/pole stars south.

Left: Aki Sinoto, Archaeologist, plane table survey/transit; Abraham Piianaia, right, from Archaeoastronomy team.

3.1 Saturday, March 21, 1992 <u>Procedure/Exhibits</u>

(a) Invited by Lt. Vern Young to visit planting sites for reforestation and land reclamation

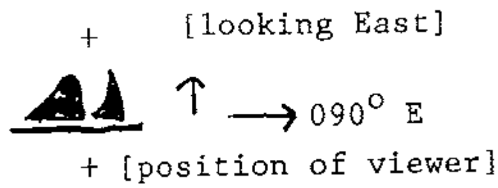
(b) To visit Pu'u Mo'iwi ancient adz quarry site

(1) Archaeology team present and working:

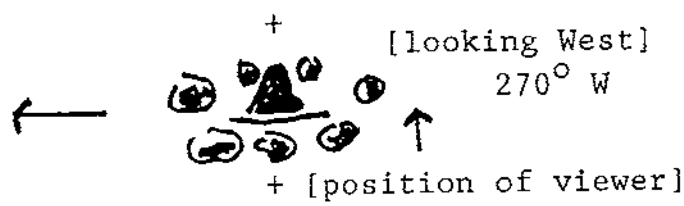
(a) Pat McCoy, archaeologist
(b) Aki Sinoto, surveyor
(c) Makanani, Hawaiian assistant

(c) Examine Pu'u Mo'iwi site which consists of:

(1) A bifurcated pillar stone facing east:

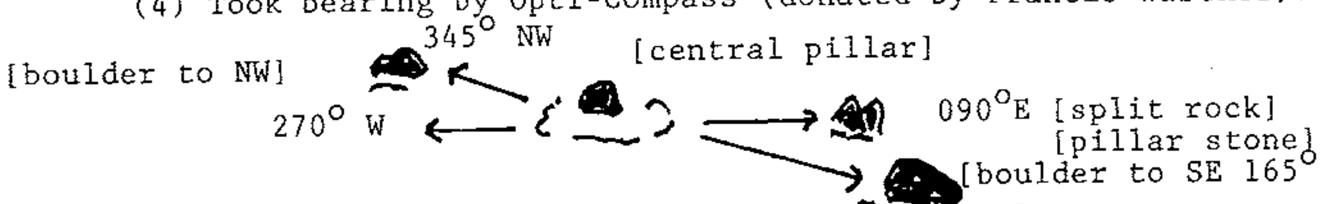


(2) A mound with a single stone centered (altar?)

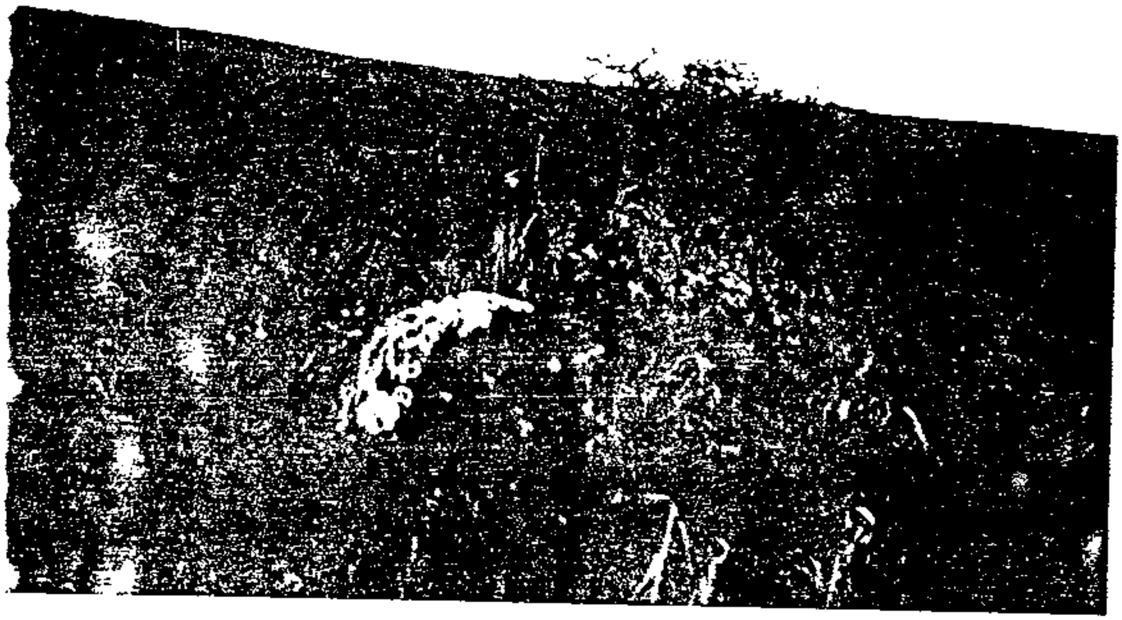


(3) A large natural boulder to south, and some natural boulders to north; bearing 345° NW

(4) Took bearing by Opti-Compass (donated by Francis Warther).

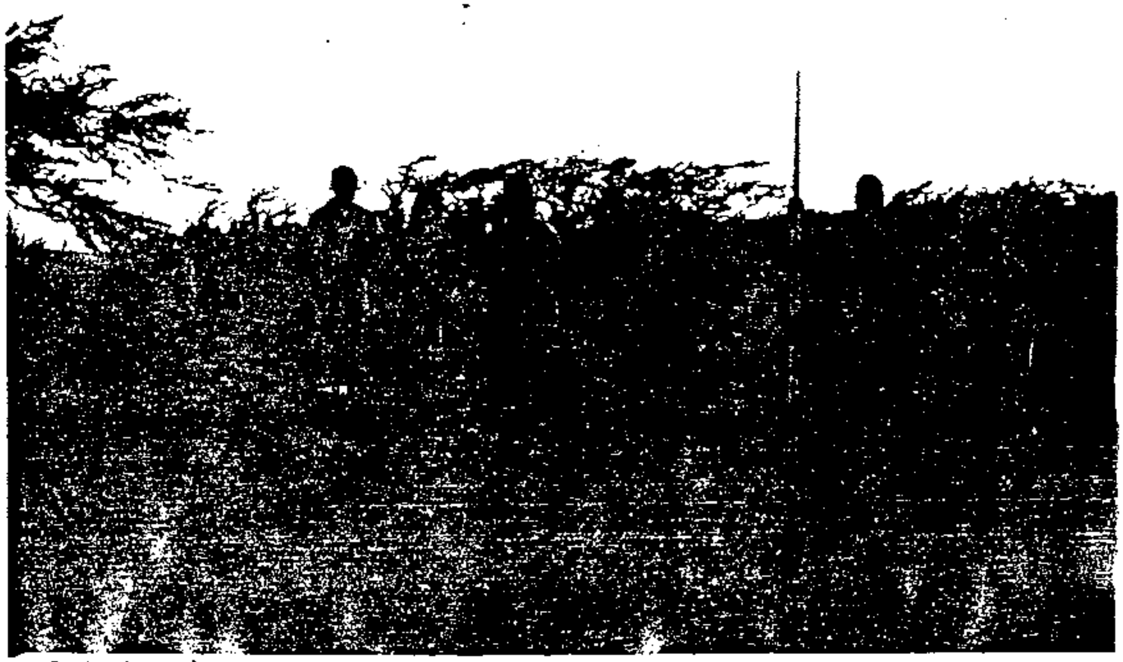


(a) 165° SE indicates approximate azimuth of Canopus rising 6:00 p.m. vernal equinox and setting 250° W at 6:00 a.m.



Pu'u Mo'iwi, March 21, 1992
(above); from central rock to
Split upright; east 090°E.
(below); mound and central
stone, 270°W.

Left to right:
Lt. Wm Klein, navigator US Navy
Lt. Vern Young, US Navy
'Ilima Pi'ianaia



Pu'u Moiwi: 3/21/92
(Above) View to 270°W central rock between split halves of bifurcated pillar stone.
On left: Lt. Wm Klein, USN; right, Lt. Vern Young

(Below) Archaeology team: Left: Michael Graves, UH Dept of Archaeology; Ilima Pi'ianaia; Pat McCoy, Archaeologist; Maka, assisting with site survey, in situ

Puu Moiwi; zerox of illustration;
Adz quarry; west to east
orientation W E;
loaned by Archaeologist Rowland Reece.

were aware of this phenomenon by their own observations, by watching the behavior of shadows cast by the sun at noon and at other times of day, i.e., the practice of gnomonics, for which there are ample obelisk pillar stones to the gods Kane (Pohaku o Kane) and Kanaloa scattered throughout the islands.

5. The list of stars used in navigation are, insofar as they have been identified, also principal navigation stars (and constellations) from a consistent set of star compasses prevalent in use throughout the Indo-Pacific (Micronesia, Polynesia, Arabia), and the instructions given show familiarity with the displacement factor in the use of horizon stars in navigation (when he says "on the sides" of the gourd, i.e., the horizon circle, "are the stars by which one navigates," and "when you arrive at the equator you will lose sight of the North Star, and then the Southern Cross will be the southern guiding star, and the constellation of 'Humu' (Altair) will stand as the guide above you"). Kaneakahoowaha, if not Kamakau, who was just the student reporter of the gourd tradition, shows that he knows that horizon stars can be used for navigation only for a while (east to west) and must be replaced by other horizon stars on those tracks, and that that principle also adheres from north to south, as one's canoe loses sight of one pole star and must reorient when it goes out of sight to the other polar guide, and that the overhead guiding star or constellation must also change. Since Kamakau did not himself sail across the equator by canoe, and since the kind of navigation practiced by the captains of the ships which brought missionary teachers to Lahainaluna were using other strategies, is it likely that Kamakau was doctoring up the gourd compass sailing directions to the European model? Was Altair important in that scheme?

4. Sunday, March 22, 1992 <u>Procedure/Exhibits</u>

(a) Asked officers to allow team to go with them to Hakioawa; answer affirmative, leaving 10:30 a.m.

(b) Field guides (military):

(1) Capt. Milton Roth
(2) Lt. Vern Young
(3) BUCS Edward A. Mroszak Jr. USN
COMNAVBASE Box 110 Code N311
Pearl Harbor, HI 96860-5020

(c) Team: R. K. Johnson   Lt. Wm. Klein
A. Piianaia
I. Piianaia

(d) <u>Plan</u> - To vist Hale O Lono/Hale O Papa heiau complex at Hakioawa Site

(1) View from 1 and 1/2 miles showed Hale o Lono on the hill but not convenient to horizon view;

(2) Requested hike to top of bluff after visiting reconstructed Hale O Lono site;

(3) Found a natural outcrop of rocks, as though used as a viewing (kilo) site; probably the same site as that listed as Site 348A Ku'ula Site (tradition of 'Ai'ai and Punia, see Beckwith, Martha W., <u>Hawaiian Mythology</u>, 1970: 19-25, appended);

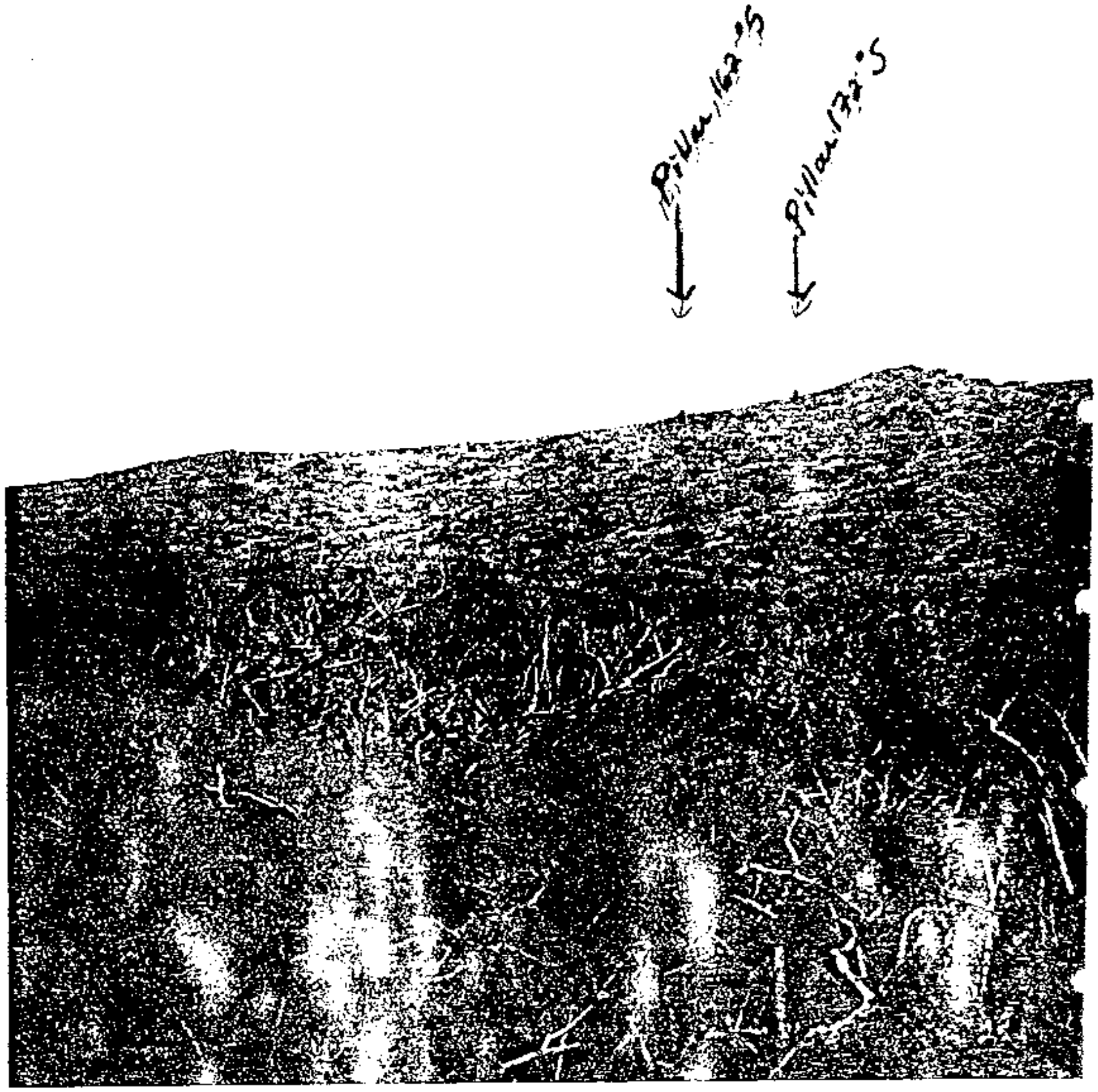
(4) Abraham Pi'ianaia sighted pillar stone (ahu) bearing 162^{o} S, approximately, and Lt. Wm. Klein discovered a small pillar stone (ahu) bearing 172^{o}S approximately, almost parallel, on a ridge south of the Hakioawa site, if not exactly parallel to Pu'u Mo'iwi bearings to Canopus, etc.

[*Note: Aiai/Punia-iki Ku'ula tradition attached, Hakioawa ku'ula site mentioned, p. 22.].

Hakioawa bluff kilo (observation) site [Site 348 A?]

Ahu sites viewed at 162° SE to 172° S on ridge to south

10.2



Pillar 162°SE sighted by A.
Canopus; Pi'ianaia; UH-Manoa
Pillar 172°SE sighted by Lt.
Wm Klein, USN.
Hakioawa Bluff. Mar. 22, 1992

tains his shape in the bed of the valley is worshiped as a rain god. As late as 1914 a keeper escorted visitors to the sacred valley to see that the god was properly respected and his influence upon the weather restrained within bounds for the benefit of the district. The legend runs as follows:

A tall foreigner comes from Kahiki and cultivates bananas of the iholena variety in a marshy spot of the valley. Pele comes to him in the shape of an old woman and he refuses to share his bananas with her. She first sends cold, then, as he sits doubled up with his hands pressed against his face trying to keep warm, she overwhelms him with a stream of molten lava. In this shape he is to be seen today encrusted in lava.

Sick people are sometimes brought to a cave near the place where stands Kumauna and left there overnight for healing. In case of drought an opelu fish is brought from the sea and struck against the rock in order to call the rain god's attention to the needs of his worshipers. In case a fish of the proper variety is lacking, a rare plant growing in the vicinity, which has leaves mottled like the sides of the opelu, may be used as a substitute. But all this must be done with the greatest reverence. Visitors to the valley are warned to be quiet and respectful lest a violent rainstorm mar their trip to the mountains. The story told of Johnny Searle has become a legend of the valley and a warning to irreverent foreigners. About the year 1896, while Johnny Searle was manager of Hi'ilea sugar plantation, there occurred a prolonged drought and one evening as he was riding home down the valley with a party of Hawaiian goat hunters he raised his gun and shot at the Kumauna boulder, exclaiming, "There, Kumauna! Show your power!" The shot broke off a piece from a projecting elbow, which some say he took home and threw into the fire. His companions fled. That night (as the story runs) a cloudburst rushed down the valley and flung great stones all over the back yard of the plantation house, where they may be seen today as proof of the truth of Kumauna's power.[9]

9. N. Emerson, *Pele*, 201–202; J. Emerson, *HHS Reports* 27: 33–35; local informants.

Rain heiau were still to be found in early days on Hawaii. A famous healing kahuna of Ka-u nicknamed Ka-la-kalohe, who worshiped his god the sun in Honokane gulch, is said to have been constantly appealed to by the white planter to invoke rain or sunshine.[10] In the Chatham islands an old Moriori could raise a favorable wind for fishing by tapping on the trunk of a special kopi tree. Other trees or rocks sent "a deluge of rain" in response to tapping.[11] In Samoa two spirits, Foge and Toafa, have charge of the rain. When a company go out after doves, offerings are made to them of taro and fish in order to insure fair weather. But if someone follows and strikes the stone which is dedicated to the two spirits, a thunderstorm will fall.[12] In Nanduayalo in the Lau islands a small rock below high-water mark brings a tidal wave if anyone strikes it or breaks off a piece.[13]

A fisherman might choose any one of various fishing gods to worship, and the tapus which he kept depended upon the fish god worshiped.[14] Ku-ula-kai (Ku of abundance in the sea) was one of these gods, some say the one who had control over all the gods of the sea. Reddish things were sacred to him. The fisherman's heiau set up at a fishing beach is called after him a kuula. The god lived as a man on earth on East Maui in the land called Alea-mai at a place called Leho-ula (Red-cowry) on the side of the hill Ka-iwi-o-Pele (The bones of Pele). There he built the first fishpond; and when he died he gave to his son Aiai the four magic objects with which he controlled the fish and taught him how to address the gods in prayer and how to set up fish altars. The objects were a decoy stick called Pahiaku-kahuoi (kahuai), a cowry called Leho-ula, a hook called Manai-a-ka-lani, and a stone called Kuula which, if dropped into a pool, had the power to draw the fish thither. His son Aiai, following his instructions, traveled about the islands establishing fishing stations (ko'a) at fishing grounds (ko'a aina) where fish were accustomed to feed and setting up altars (kuula) upon which to lay, as offerings to the fishing gods, two fish from the first catch:

10. Green and Pukui, 137–139.
11. Skinner, *Mem.* 9: 62, 63.
12. Stuebel, 149.
13. Hocart, 214, cf. 217, 218.
14. Malo, 274.

one for the male, the other for the female aumakua. Some accounts give Aiai a son named Punia-iki who is a fish kupua and trickster and helps his father set up fishing stations.

In this story the god Ku-ula-kai who supplies reproductive energy to all things of the sea is represented by his human worshiper. The man Kuula who served the ruling chief of East Maui as head fisherman has a place on the genealogical line stemming from Wakea. The fishpond over which he presided, the place where his house stood, the bones of the great eel he slew, the stone of victory (Pohaku o lanakila) set up by his son at the famous surfing beach of Maka-ai-kuloa to commemorate his triumph—all are pointed out today by natives of the locality in verification of the story. At the stone Maka-kilo-ia (Eyes of the fish watchman) placed by Aiai on the summit of Kauiki, fishermen still keep a lookout to watch for akule fish entering the bay. A haul of 28,000 were drawn up there only a few years ago. It is the old fishing technique still practised, both in its practical and its religious aspect, which is referred to Kuula's teaching. All the places named in the legend of Aiai remain as authentic fishing grounds and stations for fishermen in island waters. Nor is the old practice of offering fish from the first catch to the god upon the fish altar entirely forgotten.

STORY OF KUULA

Wahiako version. While Ka-moho-ali'i (The shark chief) is ruling chief over Hana, the god Kuula is living in human form at Leho-ula by the sea with his wife Hina-puku-ia (Hina-pupu-kae) while his brother Ku-ula-uka (Sacred one of the uplands), god of cultivators, is living in the hills with Hina's sister Hina-ulu-ohia (Laca) as his wife. The chief finds the food supply diminishing and his people in want. He appoints Kuula-kai head fisherman and Kuula-uka head cultivator for the whole island. Kuula-kai builds a fishpond with walls twenty feet thick and ten feet high and an inlet for the fish to go in and out at. The pond is always full of fish because of Kuula's power, and men crowd to see the wonder he has made. Finally appears an enemy who breaks down the walls of the fishpond. At Wailau on Molokai lives a handsome chief named Kekoona who has kupua power and can turn himself into an eel three hundred feet long. He sees the fishpond swarming with fish and slips in through the inlet, but when he has fed well he cannot get out without breaking down the wall. He goes away and hides in a deep hole about seven hundred feet beyond Alau island called "Hole of the ulua" because it is a feeding place for ulua fish. The chief's kahuna points out the enemy and his hiding place. Kuula fishes for the eel with the famous hook Manaiakalani baited with roasted coconut meat and attached to two stout ropes held by men standing on opposite sides of the bay. These draw the hooked eel to shore, Kuula kills him with a stone, and there his body lies turned to stone with one jaw smashed and the other gaping. The dog Poki is set to watch him and may be seen also turned to stone looking off to Molokai where the friends of the chief are bewailing him. Often one hears a shrill sound like mourning and the bubbles that push up into the rock pools are the tears of those who mourn.

The dead chief's favorite determines to revenge himself upon Kuula. He gets himself appointed Ka-moho-ali'i's messenger to the fishpond and one day when the chief has sent him for a fish and Kuula has given him instructions how to prepare it by cutting off its head, baking it in the oven, slicing, and salting it, he throws away the fish and pretends that Kuula's words were directed toward the chief's own body. The chief orders Kuula to be burned in his house with all his family. Because he is a god, Kuula knows of the order and prepares to save himself, his wife, and son. He bequeaths to his son Aiai his magic objects and his power of drawing the fish, instructs him about setting up fishing stations, and bids him escape with the smoke when it turns to the west; then he and his wife escape into the sea "carrying with them all the things for the people's good." Aiai escapes with his calabash from the house when the smoke turns to the west, and hides in a hole in the cliff. Three gourds pop in the fire and all believe that the three inmates of the house are consumed. A storm arises and all those who have taken part in the burning are killed.

Meanwhile the fish have followed Kuula and Hina and the pond is empty. The chief threatens the people with death if no fish is brought him. Aiai is befriended by a little boy named

Pili-hawawa and to save the family of his friend he drops the kuula stone into a pool and the fish swarm into the pool. The first fish that the chief eats slips down his throat whole and chokes him to death.

LEGEND OF AIAI

The first fishing ground marked out by Aiai is that of the Hole-of-the-ulua where the great eel hid. A second lies between Hamoa and Hanaoo in Hana, where fish are caught by letting down baskets into the sea. A third is Koa-uli in the deep sea. A fourth is the famous akule fishing ground at Wana-ula mentioned above. At Honomaele he places three pebbles and they form a ridge where aweoweo fish gather. At Waiohue he sets up on a rocky islet the stone Paka to attract fish. From the cliff of Puhi-ai he directs the luring of the great octopus from its hole off Wailua-nui by means of the magic cowry shell and the monster is still to be seen turned to stone with one arm missing, broken off in the struggle. Leaving Hana, he establishes fishing stations and altars along the coast all around the island as far as Kipahulu. At the famous fishing ground (Koʻa-nui) in the sea of Maulili he meets the fisherman Kane-makua and presents him with the fish he has just caught and gives him charge of the grounds, bidding him establish the custom of giving the first fish caught to any stranger passing by canoe. Another famous station and altar is at Kahiki-ula.

At Hakioawa on Kahoolawe he establishes a square-walled kuula like a heiau, set on a bluff looking off to sea. On Lanai he fishes for aku at cape Kaunolu and there (some say) finds Kane-apua fishing. At cape Kaena a stone which he has marked turns into a turtle and this is how turtles came to Hawaiian waters and why they come to the beach to lay their eggs, and this is the reason for the name Polihua for the beach near Paomai. On Molokai he lands at Punakou, kicks mullet spawn ashore with his foot at Kaunakakai, and at Wailau where Koona lived and where he finds the people neglecting to preserve the young fish, he causes all the shrimps to disappear and then reveals their retreat to a lad to whom he takes a fancy. This is a rocky ledge called Koki and hence the saying "Koki of Wailau is the ladder to the shrimps." Kalaupapa is still a famous fishing ground because of the stone Aiai left there. A good place for fishing with hook and line on Molokai is between Cape-of-the-dog and Cape-of-the-tree.

On Oahu, Aiai lands at Makapuʻu and makes the stone Malei the fish stone for the uhu fish of that place. Other stones are set up at grounds for different kinds of fish. The uhu is the common fish as far as Hanauma. At Ka-lua-hole the ahole fish run. The fish still spawn about a round sandstone (called Ponahakeone) which Aiai placed outside Kahuahui. It is Aiai's son Punia who, instructed by Aiai, sets up the Kou stone for Honolulu and Kaumakapili; the kuula at Kapuhu; a stone at Hanapouli in Ewa; and the kuula Ahuena at Waipio. The fishing ground outside Kalaeloa is named Hani-o; grounds for Waianae are Kua and Maunalahilahi; for Waimea, Kamalino; for Laiemaloo, Kaihukuuna. The two, father and son, visit Kauai and Niihau and finally Hawaii, where the most noted fishing grounds are Poo-a, Kahaka, and Olelomoana in Kona; Kalae in Kau; Kupakea in Puna; I in Hilo.[15]

STORY OF PUNIA-IKI

(*a*) *Thrum version.* At Kakaako, Aiai lives with a friendly man named Apua. The chief Kou is a skilful aku fisher at his grounds from Mamala to Moanalua. At Hanakaialama lives Puiwa and she seeks Aiai for a husband and they have a son Puniaiki. One day while she is busy gathering oopu and opae the child cries and when he asks his wife to attend to it she answers him saucily. Aiai prays and a storm raises a freshet which carries away fish and child downstream. He sees Kikihale, daughter of Kou, pick up a large oopu from the stream and recognizes his child transformed into a fish. The chiefess makes a pet of it and feeds it on seamoss. One day she is amazed to find a man child in its place. She determines to have the child reared to become her husband, and this comes to pass. When she reproaches him for doing nothing but sleep, he sends her to ask for fish-hooks from her father, but burns as useless the innumerable

15. Thrum, *Tales*, 215–249 (from the Hawaiian of Moku Manu); Thomas Wahiako, sheriff for Hana district, Maui, June 10, 1930 (and other local informants); For. Col. 6: 172–175; J. Emerson, *HHS Papers* 2: 17–20; Ellis, *Tour*, 88.

hooks which Kou sends him. In a vision Aiai appears to him at Kaumakapili where is the famous lure Kahuai which he had from his father Kuula. With this in hand, Punia fills the canoe with aku, which fairly leap into the canoe after the lure.[16]

(*b*) *Fornander version.* Kuula and Hina live at Niolopa, Nu'uanu, and are famous for their luck in fishing. This comes from a pearl fishhook named Kahuoi, which is guarded by the bird Ka-manu-wai at Kau-maka-pili. When it is let down into the water the fish jump after it into the canoe. Kipapalaulu, ruling chief of Honolulu, steals the hook. Hina bears the child Aiai and throws him into the Nu'uanu stream. He is borne downstream to the bathing place of Kipapalaulu's daughter Kauaelemimo near the rock Nahakaipuami [pointed out today in the Nu'uanu stream]. The chiefess brings up the beautiful child and takes him for her husband. When about to bear a child she craves aku fish and Aiai bids her ask her father for his pearl fishhook and a big canoe for fishing. He makes a great haul of fish, which he brings to his wife, but the hook he returns to the care of the bird, which has been ailing since the loss but which now recovers strength.[17]

STORY OF PUNIAKAIA

Puni-a-ka-ia (Hankering after fish), the handsome son of high chiefs of the northern districts of Oahu named Nu'upia and Hale-kou, who live at Kaneohe, nurses the fish Uhu-makaikai, parent of all the fishes, and his pet drives fish into his nets. He marries a pretty, well-behaved woman named Kaalaea, to whom he and his father and mother bring gifts according to custom. She gives herself alone by coming to him and placing herself in his lap. He goes to live with her family but they insult him for doing nothing but sleep and he goes away to Kauai, takes a high chiefess to wife, and lays a wager to bring in a great catch of fish. His pet fish in the pool at Nu'upia, apprised by his mother of the wager, sends him fish enough to win the whole island of Kauai. He gives these away to the men who have taken him across to Kauai and returns to Oahu with his new wife.[18]

16. *Tales*, 242–249.
17. For. Col. 4: 554–559.
18. *Ibid.* 5: 154–162; Dickey, *HHS Reports* 25: 19.

10.6

The theme of the stolen luck-bringing fishhook is common in the South Seas. It occurs again in Hawaii in the story of Iwa the master thief, which appears in a later chapter.

New Zealand. Tau-tini, son of Tari's sister Hine-i-taitai, recovers the fishhook which Ra-kuru, brother-in-law of Tari, stole from Rari.[19]

Tokelau. Kalokalo-o-ka-la, child of the Sun in Fakaofa, starts up a tree to visit his father in order to get a lucky fishhook as a bridal present for his wife. Directed by an old blind woman whose eight taro sprouts he has broken off and whose sight he has restored, he passes stinging insects, then crabs, goes through a spinning door, and finds his father. He is given a bundle and told not to open it, but does so and is swallowed by a shark because the Sun is angry. The hook falls into the sea and is taken by the Fiji chief and shaped into a lucky spoon bait. Hina's husband tries it and is so pleased with it that he carries it away with him. The whole wedding party except Hina are in consequence drowned. Hina returns to her father and her child Tautini gets possession of the shell and is successful in bonito fishing until he loses the hook.[20]

Samoa. 'Alo'alo is sent to heaven after the lucky fishhook in order to satisfy his wife's pregnancy craving for fish. He disobeys the tapu and falls into the sea near Fiji and the hook he has obtained is lost.[21]

Tonga. (*a*) An old man's daughter is taken to the sky. A man crawls up the fishline leading to the sky and she bears twins. The twins are sent to their grandfather for "the hook for pulling up land." The old man tells them to select a bright hook, but they take the dull one and it turns out to be the lucky hook.[22]

(*b*) Maui-kisikisi comes to Manu'a after a lucky fishhook, meets the fisherman's wife Tavatava-i-Manuka, and wins from her the secret that the dull-looking hook is the one he must take.

19. White 1: 170–172.
20. *JPS* 32: 168–170.
21. Krämer 1: 412–416.
22. Gifford, *Bul.* 8: 20.

4. (e) Synopsis of Ku'ula/Aiai/Punia-iki tradition.

(a) Ku'ula-kai and Ku'ula-uka are Ku gods representing the abundance ('ula) of the sea (kai) and (upland), patronized by the fishermen and farmers at ko'a shrines:

(1) ko'a-kai - fishing shrines, uprights, coastal
(2) koa'-uka - harvest shrines, uprights, upland

(a) at these shrines offerings were made from fishing and farming on a daily basis

(b) Ku'ula-kai and Ku'ula-uka rituals are coordinated with their companions, Hina-puku-i'a and Hina-puku-'ai, indicating that the role of the moon for regulation of tides and for the moon calendar regulating agriculture is a Ku/Hina worship pattern

(c) Ku'ula-kai, the fish-god [as a stone image at the ko'a-kai]

(1) reddish things are sacred to him ('ula)
(2) connected to island areas

(a) East Maui: (1) Ka-iwi-o-Pele, Leho'ula, Aleamai
(2) Four magic objects:
(a) decoy stick, Pahiaku-kahuoi
(b) cowry, Leho'ula
(c) hook, Manaiakalani
(d) stone, Ku'ula, drew fish

(3) Aiai, son of Ku'ula-kai

(a) set up fishing stations (ko'a) at fishing grounds (ko'a 'aina), set up altars (ku'ula) upon which to lay offerings to fishing gods, two fish from first catch;

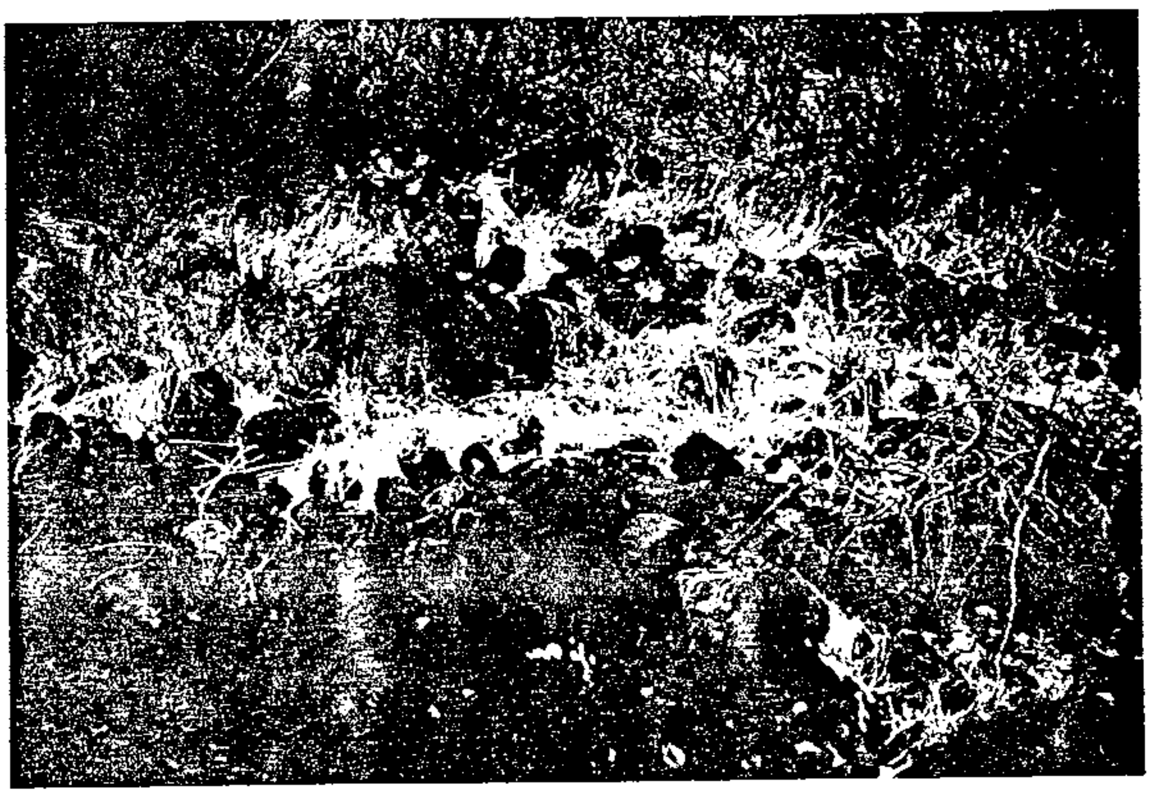
(4) Ku'ula-kai lived in Leho'ula in the time Kamoho-ali'i was the district chief of Hana

(a) The first Kamohoali'i was Pele's older brother, during the Pele migration to Hawaii from Borabora;

(5) Aiai sets up fishing grounds:

(a) "Hole-of-the-ulua" (at Alau Is., Maui)
(b) Between Hamoa and Hanaoo, Hana (Maui)
(c) Koa-uli, deep sea
(d) Wana'ula ('akule)
(e) Honomaele (aweoweo)
(f) Waiohue (stone Paka to attract fish)
(g) Puhi-ai cliff, Wailua-nui
(h) Kipahulu (Maui) in Ma'ulili, Kahiki'ula
*(i) Hakioawa (Kaho'olawe), "establishes a square-walled ku'ula like a heiau, set on a bluff looking off to sea"
(j) Lana'i, at Kaunolu, at Kaena (turtle, Polihua)
(k) Punakou (Molokai), Kaunakakai (mullet), Wailau (etc.)

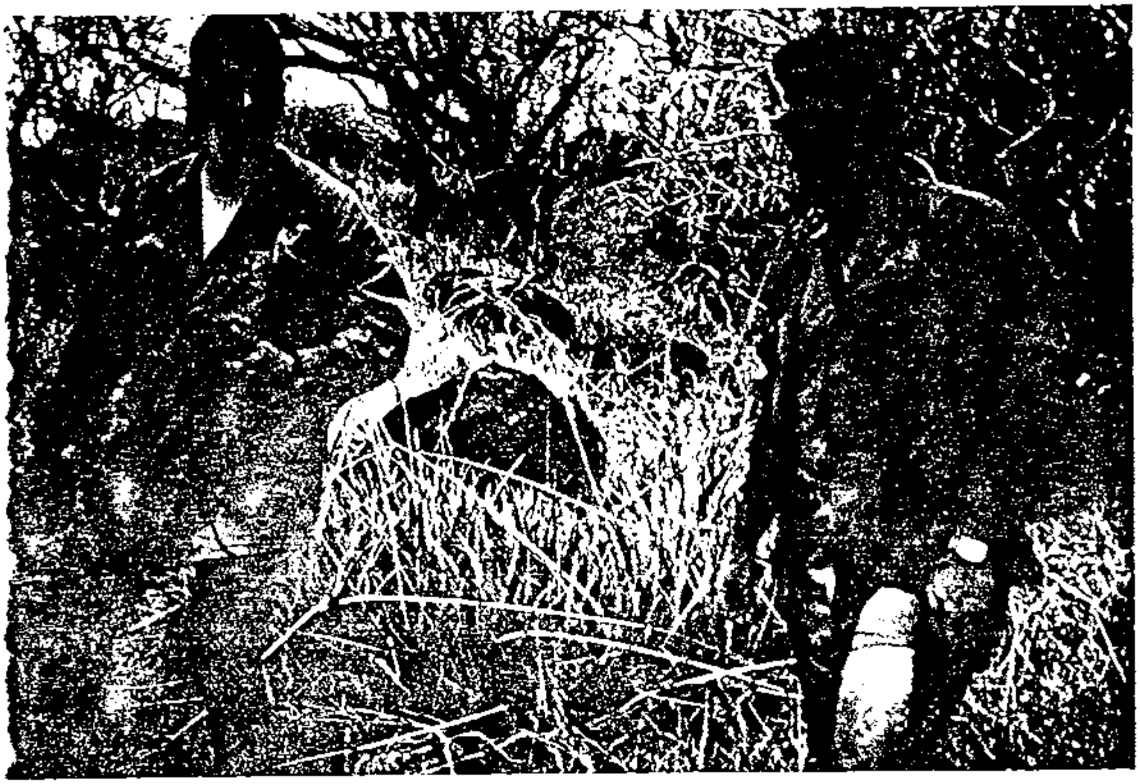
11.1



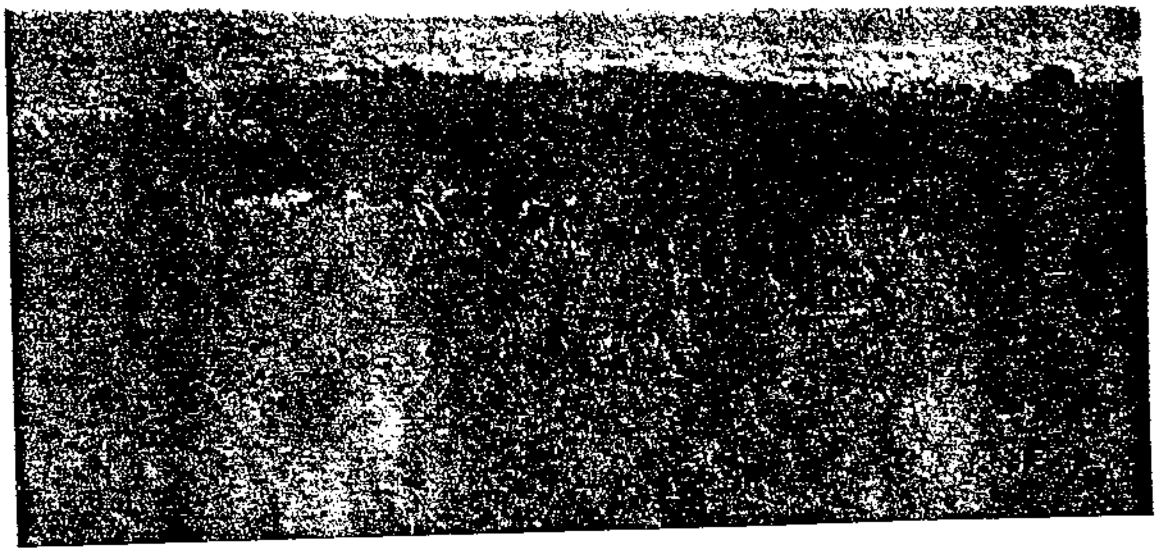
Hale o Lono, interior, Hakioawa.
No discernible celestial alignment, but needs to be charted, surveyed, etc.

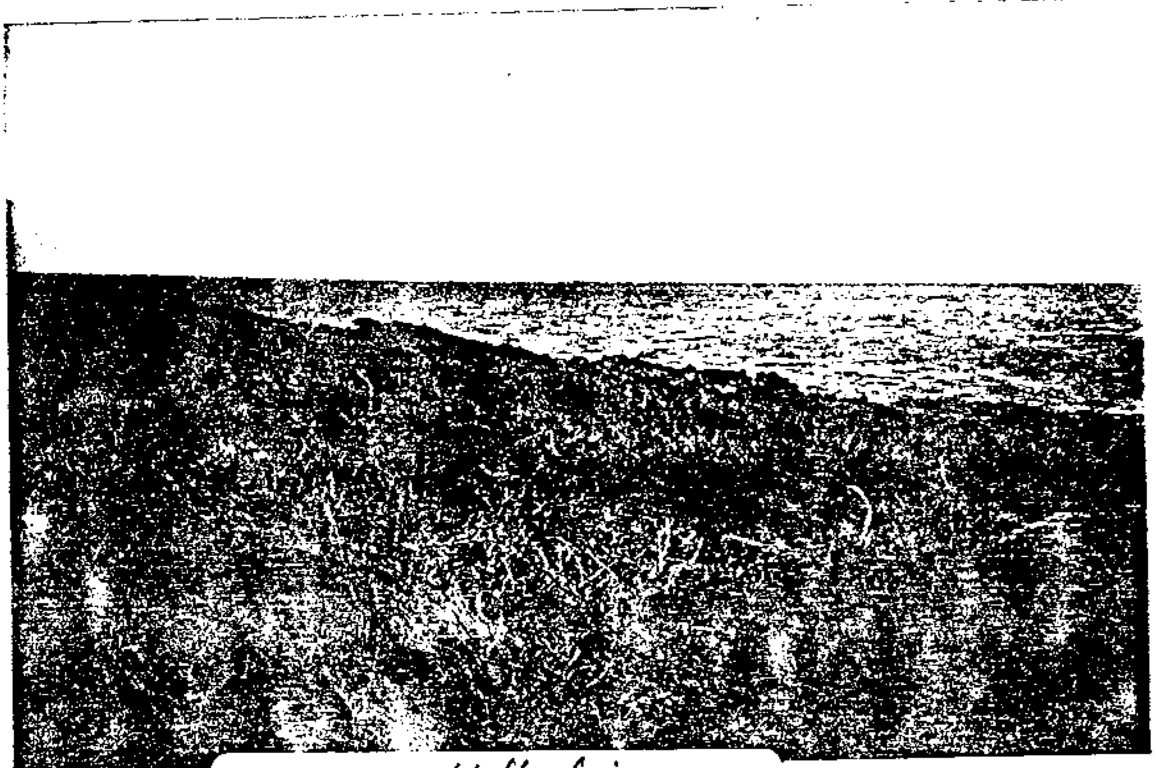
Hakioawa, March 24 1992
(Above) View from Hale o Lono
north to Hale o Papa
(Below) View from Haki'oawa to
Molokini, West Maui

Nakieawa, bluff; facing Molokini.
(Above) left-right: Abraham Piianaia, Ilima Piianaia, Capt. Milton Roth, USN.
(Below): I. Piianaia, M. Roth; Lt. Wm Klein, V. Young, E. Mroslak, USN.



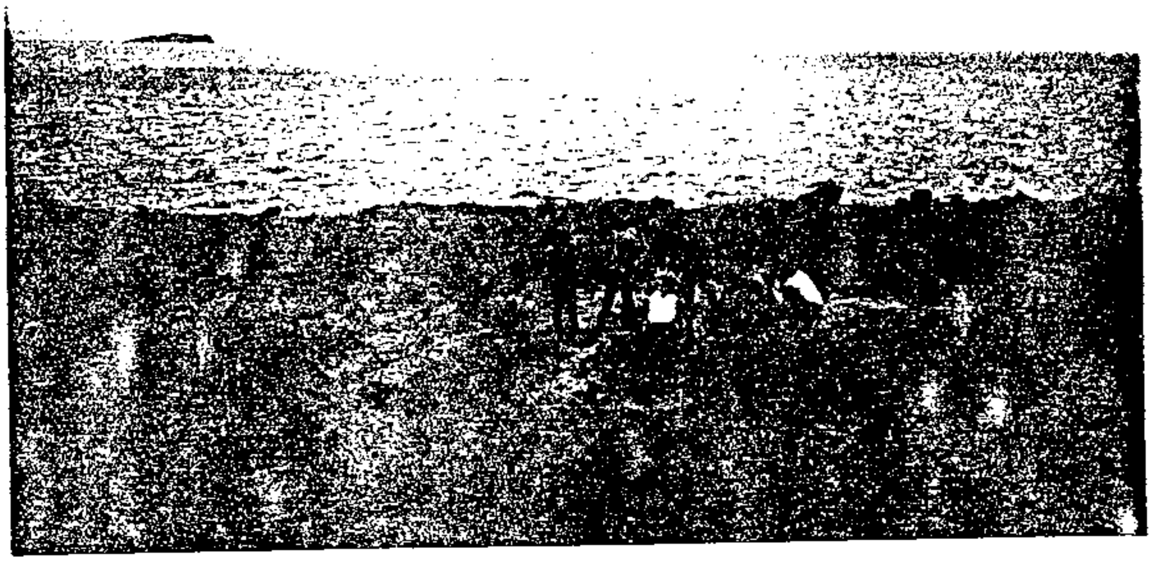
Hale o Lono, Hakioawa, Mar. 23, 1982
(Above) left to right, Lt. Vern Young;
Senior Officer Edward Mroszak, USN.
Hale o Lono wall, mapele type?
No celestial alignment of walls.

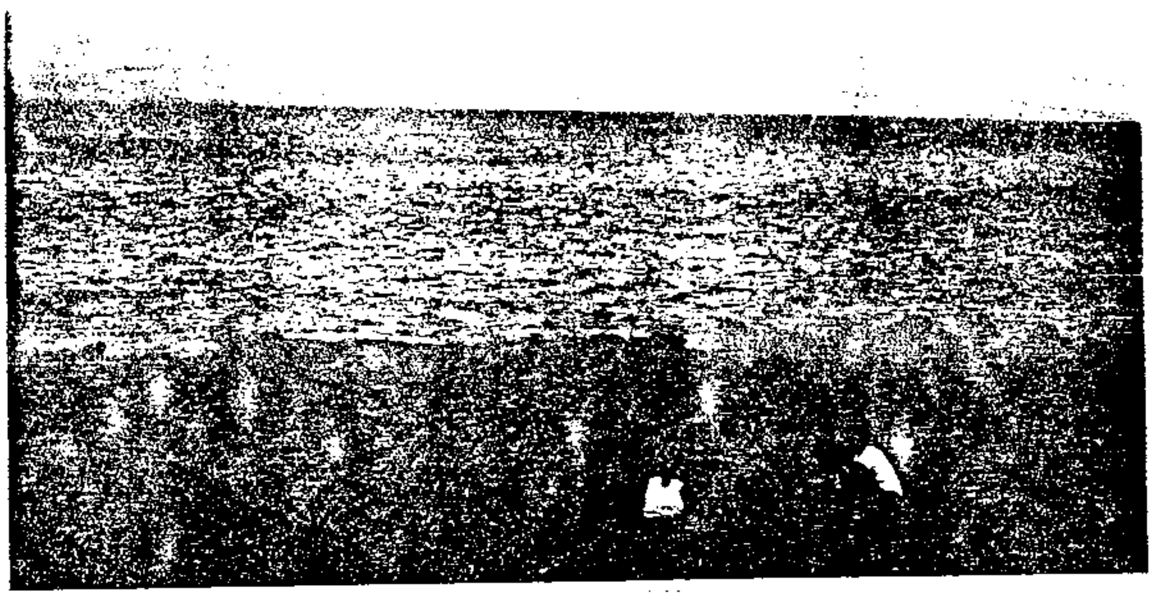




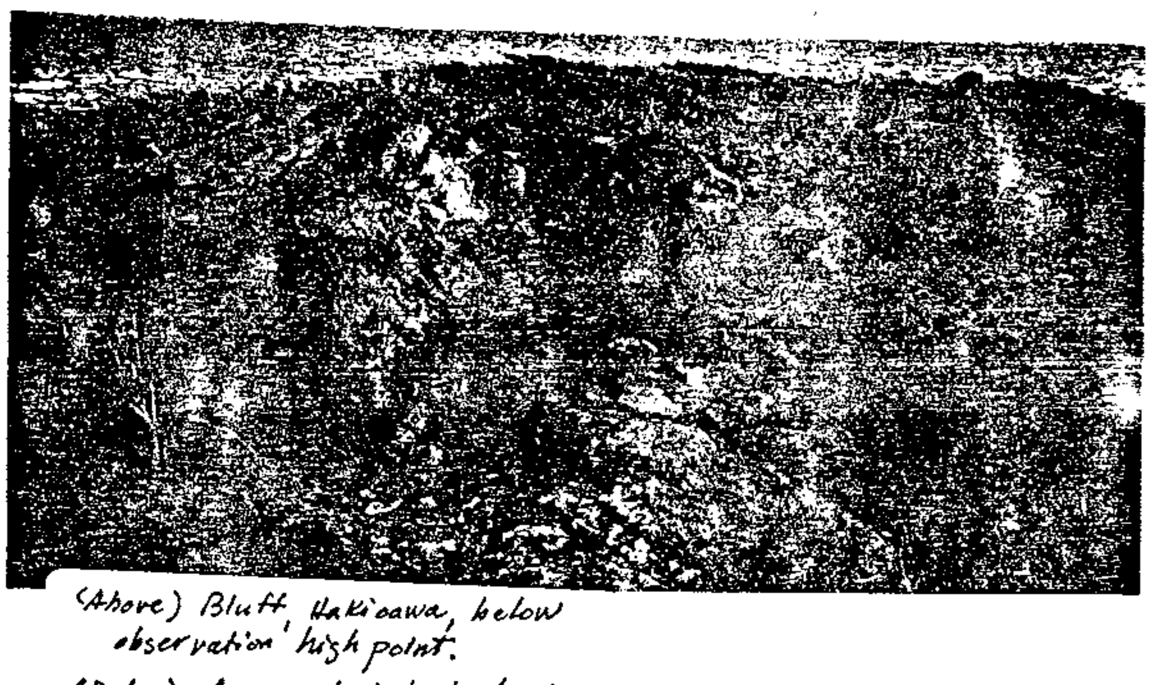
Hakioawa, bluff; facing Haleakalā, We. Maui. Coastal area below high point.

Hakioawa Bluff, facing We. Maui,
Area where group is relaxing is
below highest point of
observation. (Ram)
Mar. 23, 1992.





Hakioawa Bluff, to area We.
Maui, from Puu Ola'i - Kahikinui
(Makena).
Viewpoint from high point of
lookout. (Team)



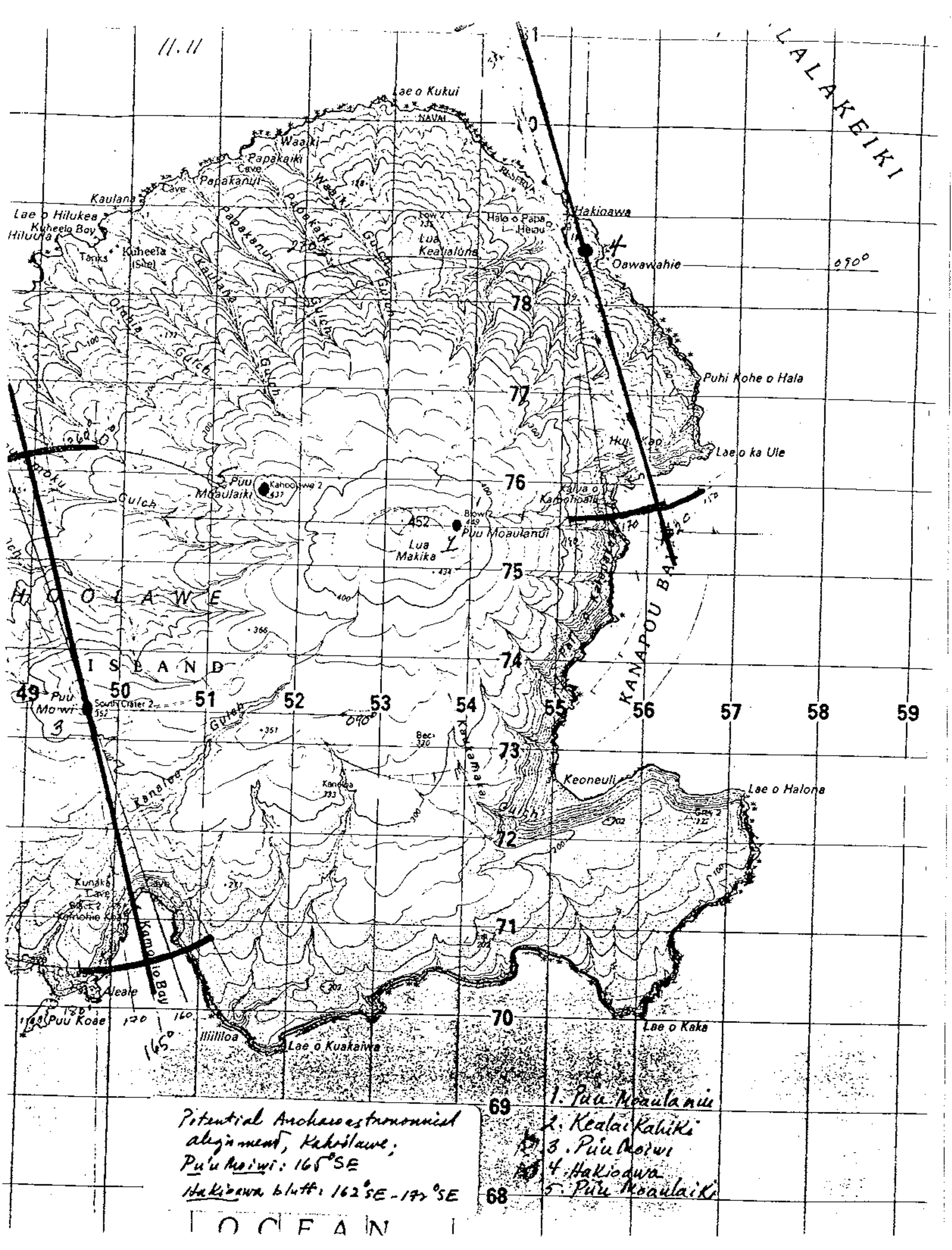
(Above) Bluff, Hakioawa, below observation high point.

(Below) Approach to highest observation point, rock outcrop.

(Above) Group area to coast view, northeast, Hakibawa coast/bluff.
(Below) Close-up view of stone cluster in situ from below viewpoint; seems to have been occupied.

Closeup, vantage point from outcrop elevation; Hakioawa Kilo station for this viewing; produced the view to southeast. (Above)

(Below): View to southeast from observation point; pillar stones on next ridge over within sight range to Hakioawa — Hale o Papa.


11.11
KALALAKEIKI
Lae o Kukui
NAVAL
RESERVA
Waaiki
Papakaiki
Cave
Papakanui
Kaulana
Lae o Hilukea
Kuheeia Bay
Hiluuia
Tanks
Kuheeia
Hakioawa
Halo o Papa
Heiau
Lua Keaalaluna
Oawawahie
090°
Puhi Kohe o Hala
Lae o ka Ule
Puu Moaulaiki
Kahoolawe 2
Kalua o Kamohoalii
Puu Moaulanui
Lua Makika
452
K A H O O L A W E
I S L A N D
KANAPOU BAY
Puu Moiwi
South Crater 2
Keoneuli
Lae o Halona
Kanaloa
Kamohio Bay
Kunaka Cave
Aleale
Puu Koae
Ililiiloa
Lae o Kuakaiwa
Lae o Kaka
O C E A N
49 50 51 52 53 54 55 56 57 58 59
78 77 76 75 74 73 72 71 70 69 68
165°
Potential Archaeoastronomical alignment, Kahoolawe;
Pu'u Moiwi: 165°SE
Hakioawa bluff: 162°SE - 172°SE
1. Puu Moaulanui
2. Kealai Kahiki
3. Puu Moiwi
4. Hakioawa
5. Puu Moaulaiki

4.f. Sunday, March 22, 1992: Assessment of Hakioawa [Site 348A] Bluff sighting of Hawaiian ahu sites and possible relationship to Pu'u Mo'iwi alignments to north/south polar (meridian) ambit.

These sightings produced an exhilarated response as they seemed to corroborate what had been deduced from the alignments, if potentially there, observed at Pu'u Mo'iwi.

On reflection, however, the pillar stones (ahu) require archaeological study in situ, as they may be other possibilities, however unlikely the prospect may be, if non-Hawaiian and late positioning, if not by ancient Hawaiians, then by ranch personnel, etc.

However, they are in a raw location, unmapped (?) and heretofore undetected (?), either by observers and not recorded in any literature.

Until they have been charted, mapped, studied, they are only potential possibilities of alignment.

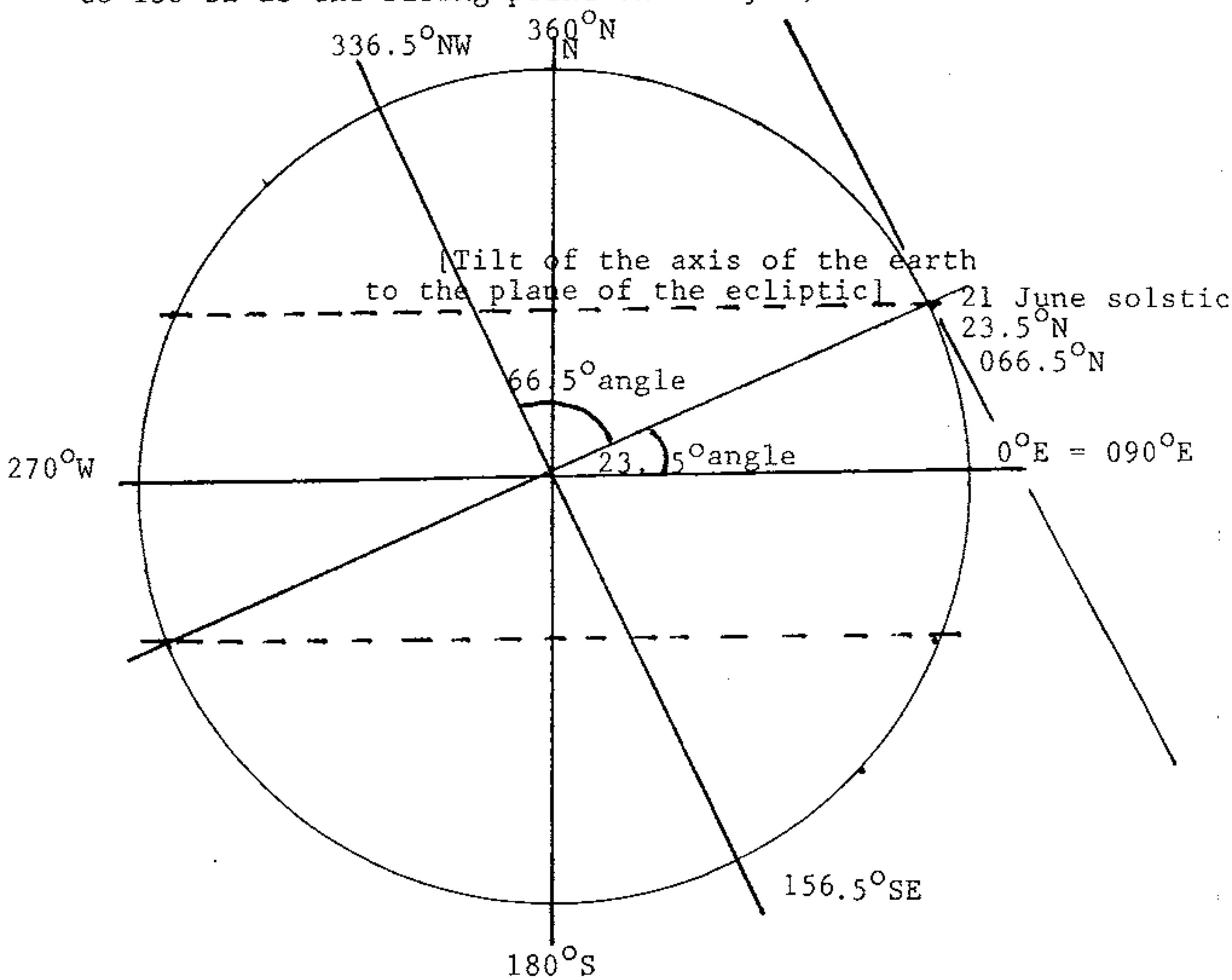
Chances are good that they were placed there by ancient Hawaiians, and that they are as we believe, pillar markers of celestial positions as they would not serve very many other purposes.

5. Moday, March 23, 1992 Procedure

(a) Invitation from base command to visit site at Pu'u Moa'ula-iki: [Tradition of Keawe-iki Rock "bell stone"]:

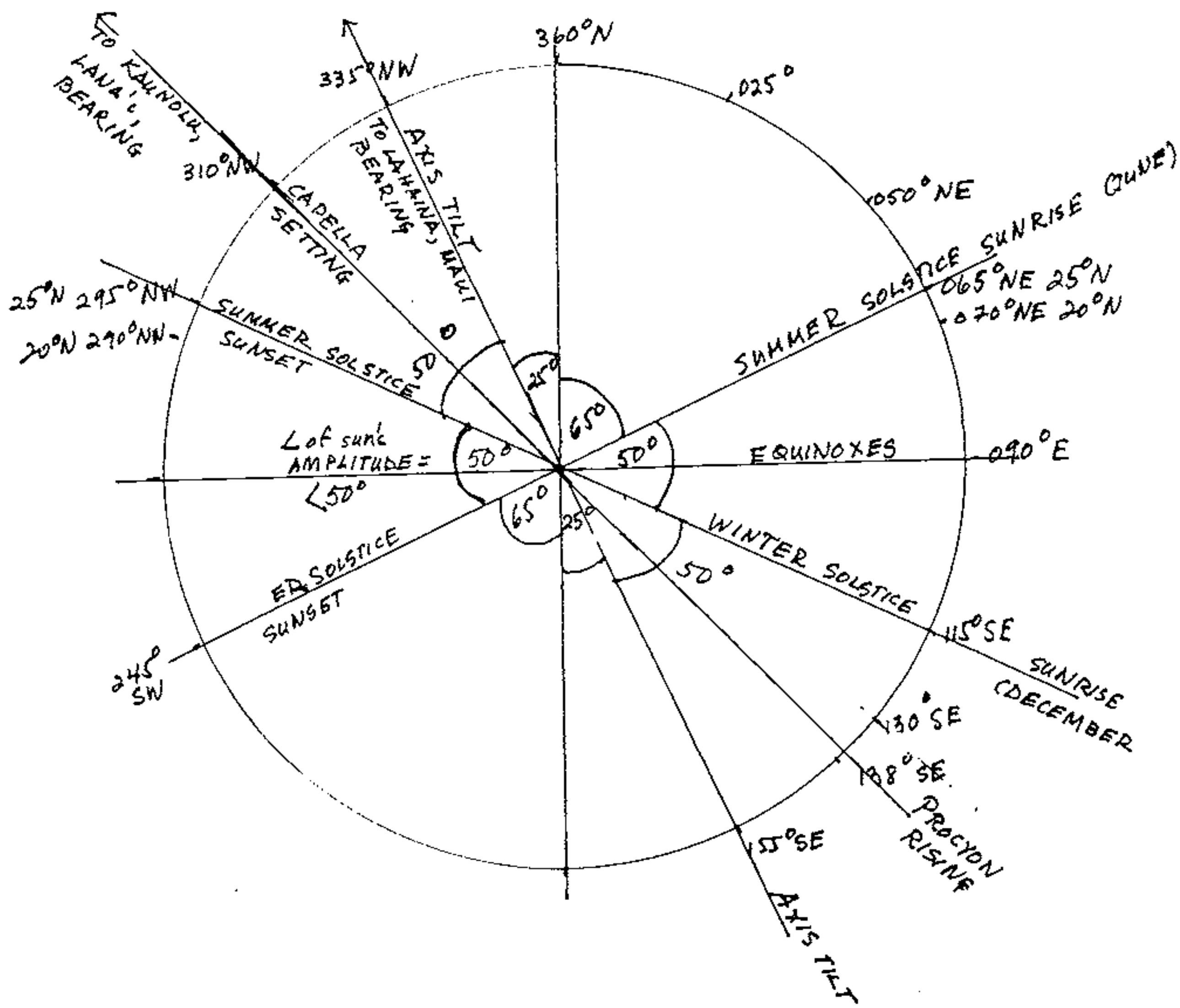
(1) Tilt of axis of a compass stone is, according to reports, credited to Homer Hayes regarding the navigation plans of the Hokule'a voyaging canoe in 1976, to retrace the route from Ke-ala-i-Kahiki (west Kaho'olawe coast) 'The-way-to-Tahiti', by aligning Pu'u o Hōkū (Moloka'i) east end to Ke-ala-i-Kahiki (Kaho'olawe) west end, the tilt determined by the position of a bell stone, a prominent object at the end of the ridge of Pu'u Moa-'ula-iki, but it could not be determined without tools to measure the angle of tilt; however:

(2) Sighting along the diagonal cleft in the rock produced no significant data except that the diagonal alignment to the horizon points to the setting position of Capella in Auriga at 310°NW, so that the advantage from that alignment of the rock is to its reciprocal heading backsight to 138°SE as the rising point of Procyon, thus:



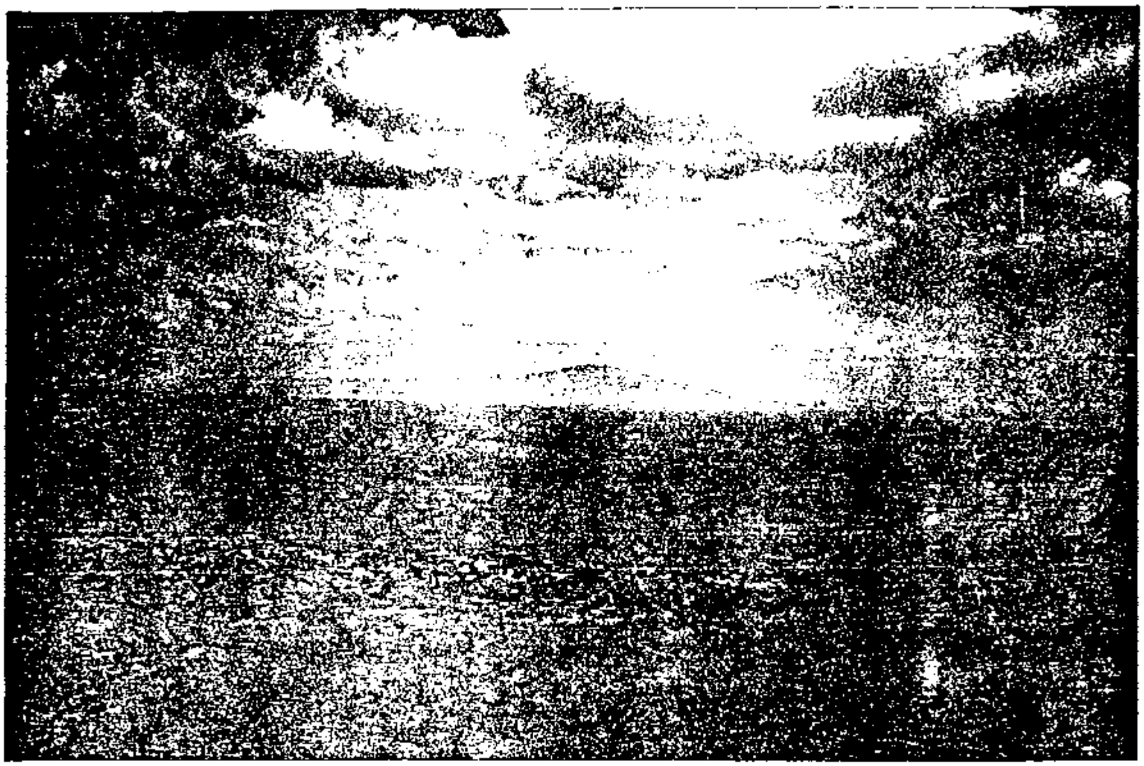
(3) The solution above timed to the position of the sun at June solstice is to Latitude 23.5°N (Nihoa), azimuth 066/5°N and must be adjusted to the latitude of Kaho'olawe;

It is not yet sufficient to my understanding, however, an observer at 20°N or thereabouts (Kawaihae to Kaho'olawe) sees the solstice sun (summer) at 065°N and makes the corresponding sight to winter solstice at 115°S (December 21). The angle of the amplitude of the sun is 50°. The axis tilt to the plane of the horizon circle at Kaho'olawe's latitude, Pu'u Moa'ulaiki is adjusted to about 335°NW (or 25° west of north as the corresponding degree of compensation). The setting azimuth of Capella 310°NW is a 50° compensation (perhaps) to the amplitude of the sun (?), or was Capella on the axis tilt setting at 335°NW in the past (?). I have no answers to this one, however, as significant, I believe, is the bearing from Moa'ulanui to Kaunolu at the extreme western side of Lana'i is 310°W while the 335°NW bearing of the axis tilt from Pu'u Moa'ulaiki is to the extreme west end (Lahaina) of Maui (see p. 6.3).



Pu'u Moa'ulaiki, Mar. 23, 1992
"Bellstone", Keaweiki shrine;
Kilo site; needs more study.

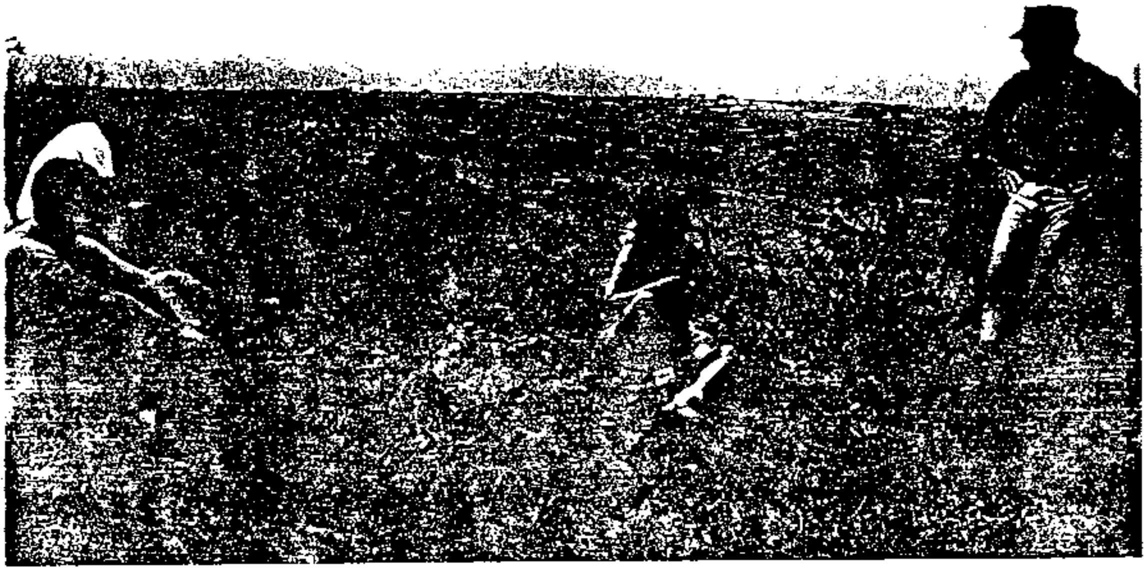
(Above) Lt. Vern Young
(Below) Left-right: A. Piianaia
I. Piianaia
M. Roth
V. Young

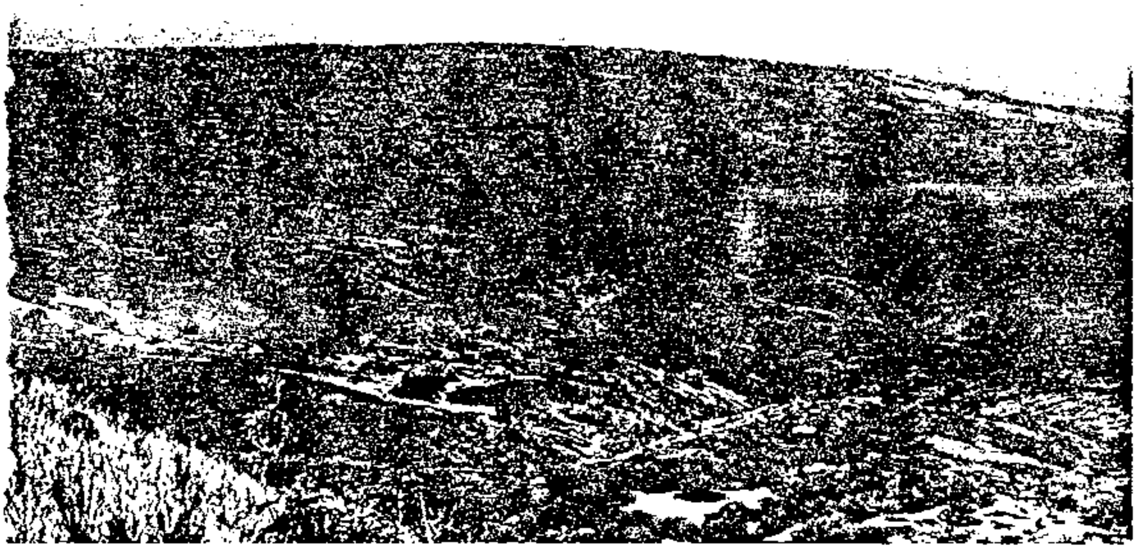


Puu Moaulaiki; View toward Lana'i.
(Below l-r): A. Piionaia W. Klein
I. Piionaia V. Young
M. Roth
Mar. 23, 1992 Monday

14.2

Pu'u Moa'ulaiki, Mar. 23, 1992
View toward Lana'i (above)
View toward Maui (below)
L-R: A. Pi'ianai'a, M. Roth, V. Young
I. Pi'ianai'a, W. Kluk.





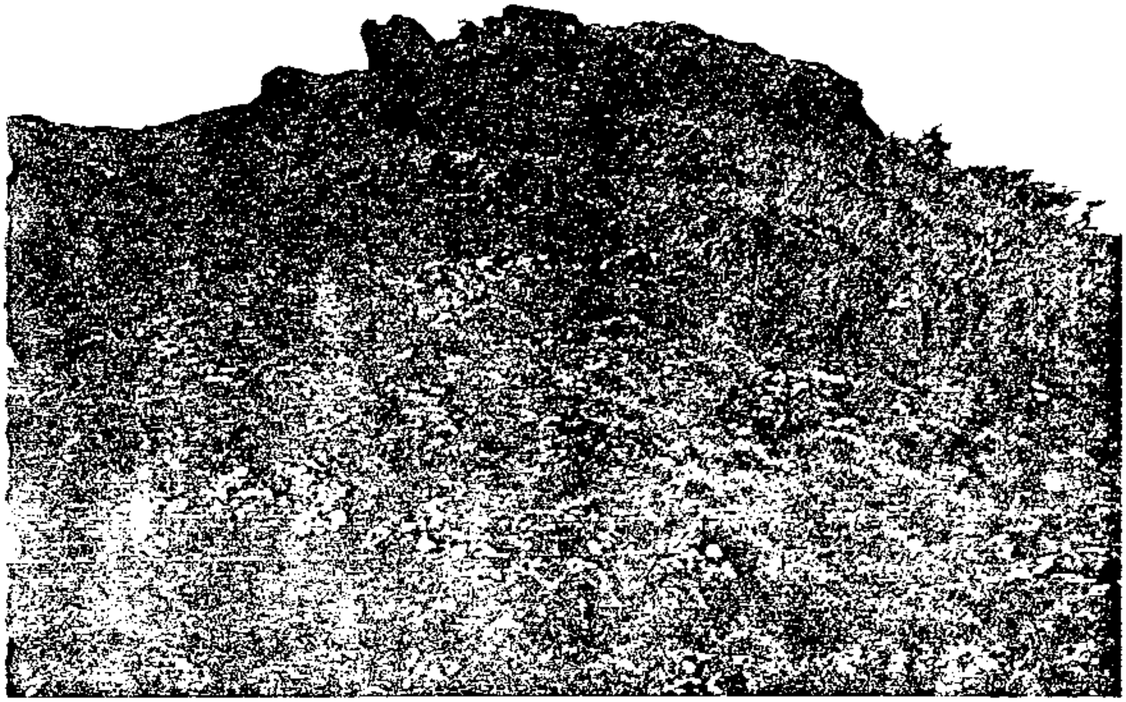
Pu'u Moa'ulaiki
View toward SW target area

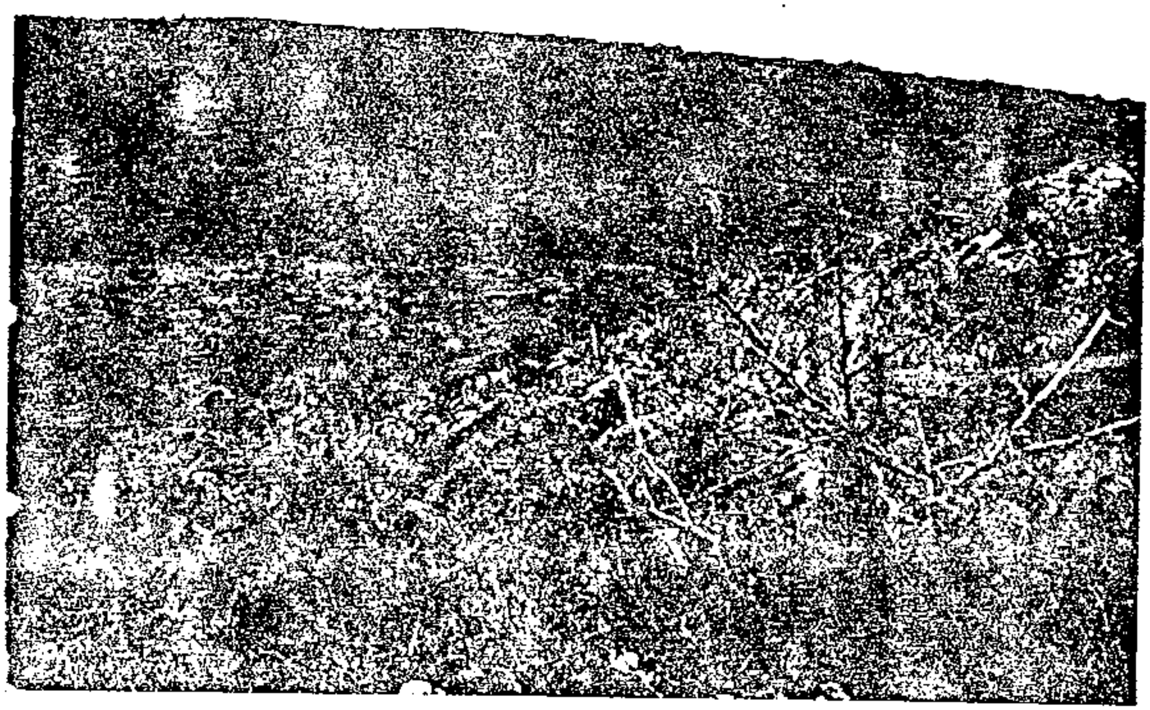
Mar. 23, 1992

L - R: W. Klein, V. Young, J. Pi'ianai'a, M. Roth.

14.4

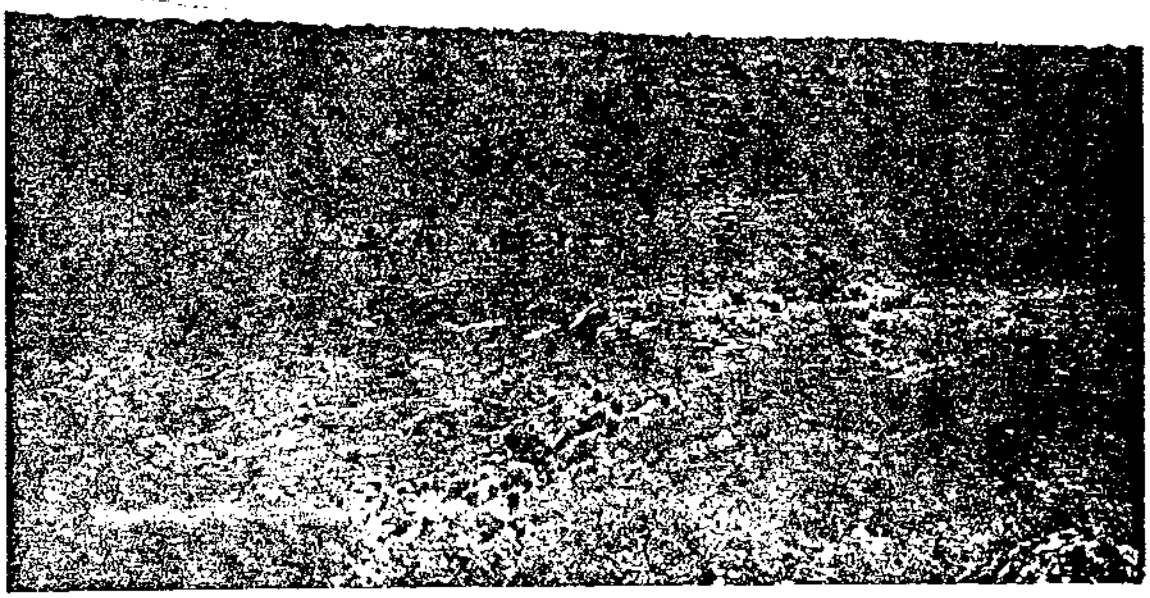
"Bellstone" - Keaweiki
(Above) I. Pilanaia, M. Roth A. Pilanaia
(Below) Area below high point, looking up toward bellstone.

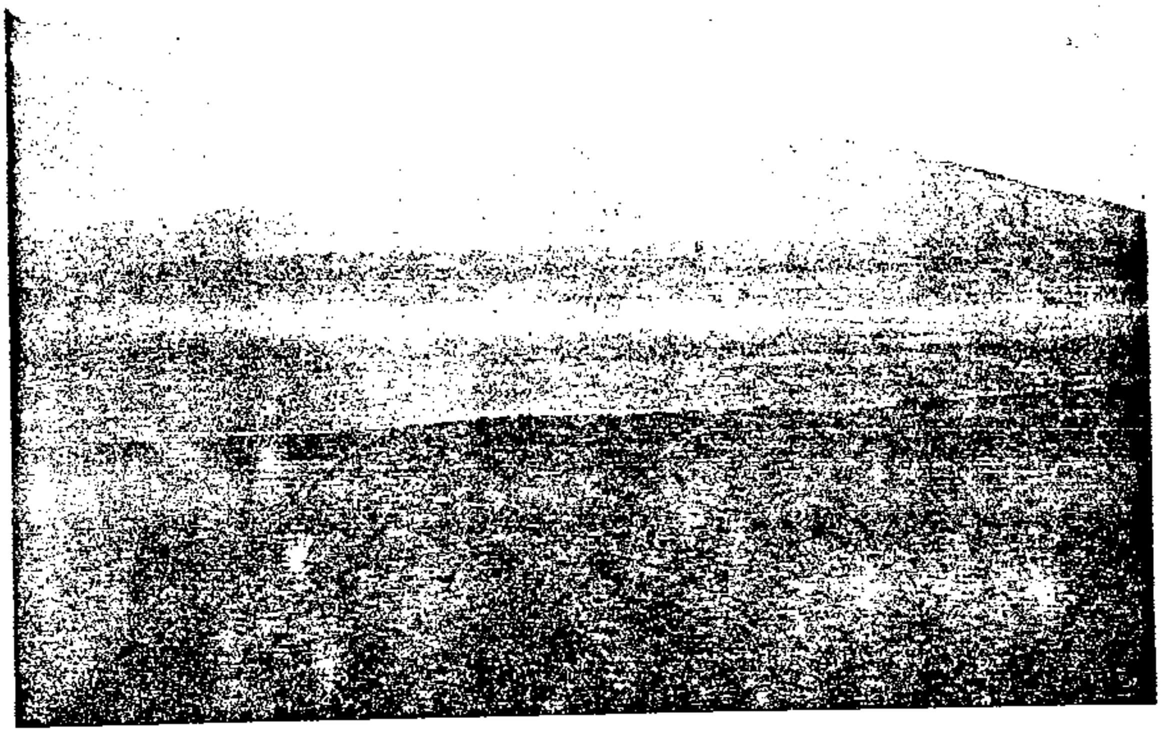




(a) View at Pu'u moe'ulaiki from below bellstone area

(b) View toward reforestation area NE. Mar. 23, 1992



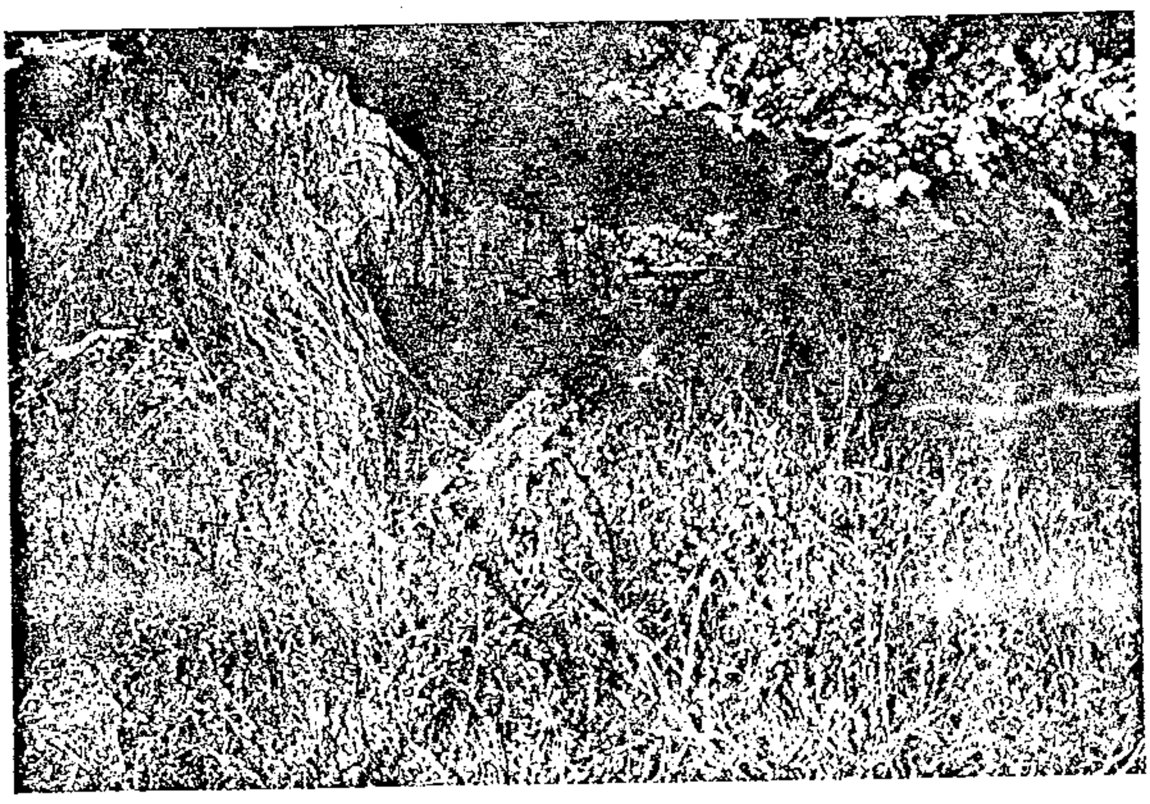


Pu'u Moa'ulaiki

Views toward Pu'u Ola'i;
Haleakala, East Maui;
reforestation area below.

Reforestation area, from
Puu Moaulaiki, to
Molokini, East Maui
from Puu Hua'ulaiki

Bell stone, Puu Moa'ulaiki
CRevice and tilt; crevice
points to Kuke'a Bay?
310° NW = Capella, Auriga
130° SE = (?) 138° SE Procyon.)?

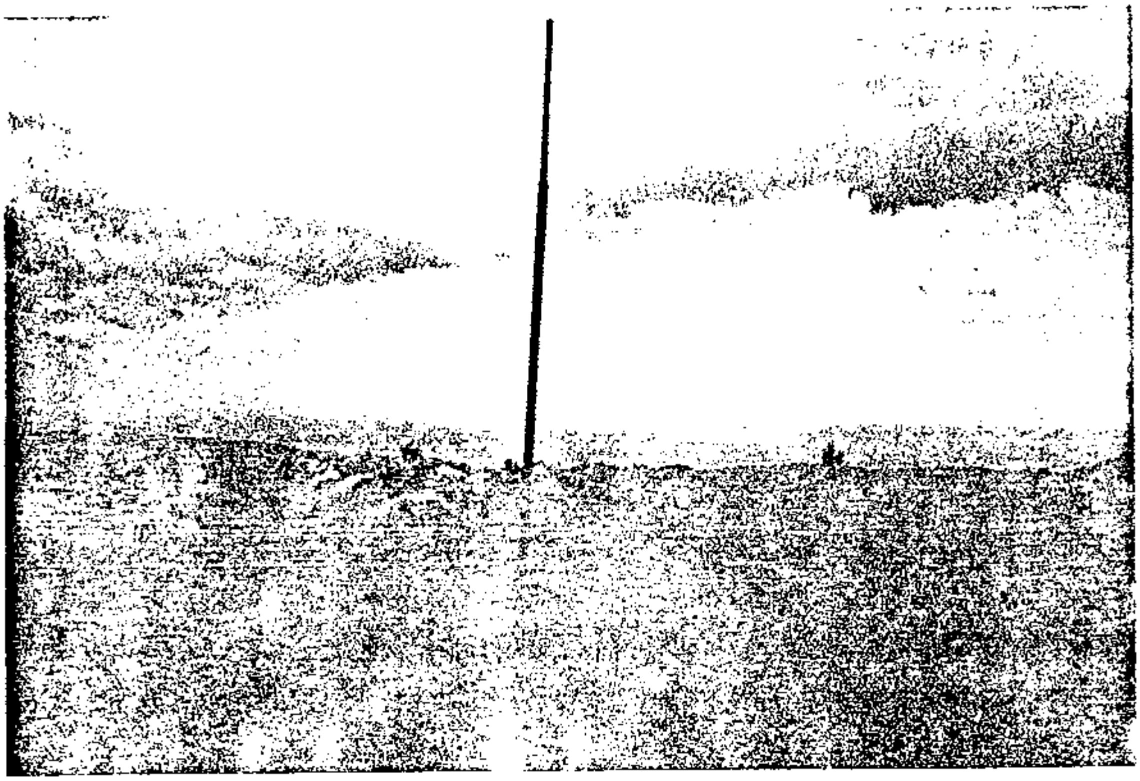


Gourds under bell stone
(Below)

(Above) Keaweiki rock;
Puʻu Moaʻulaiki; sighting
along crevice, March 23, 1992.
Capella / Procyon reciprocal?

14.10

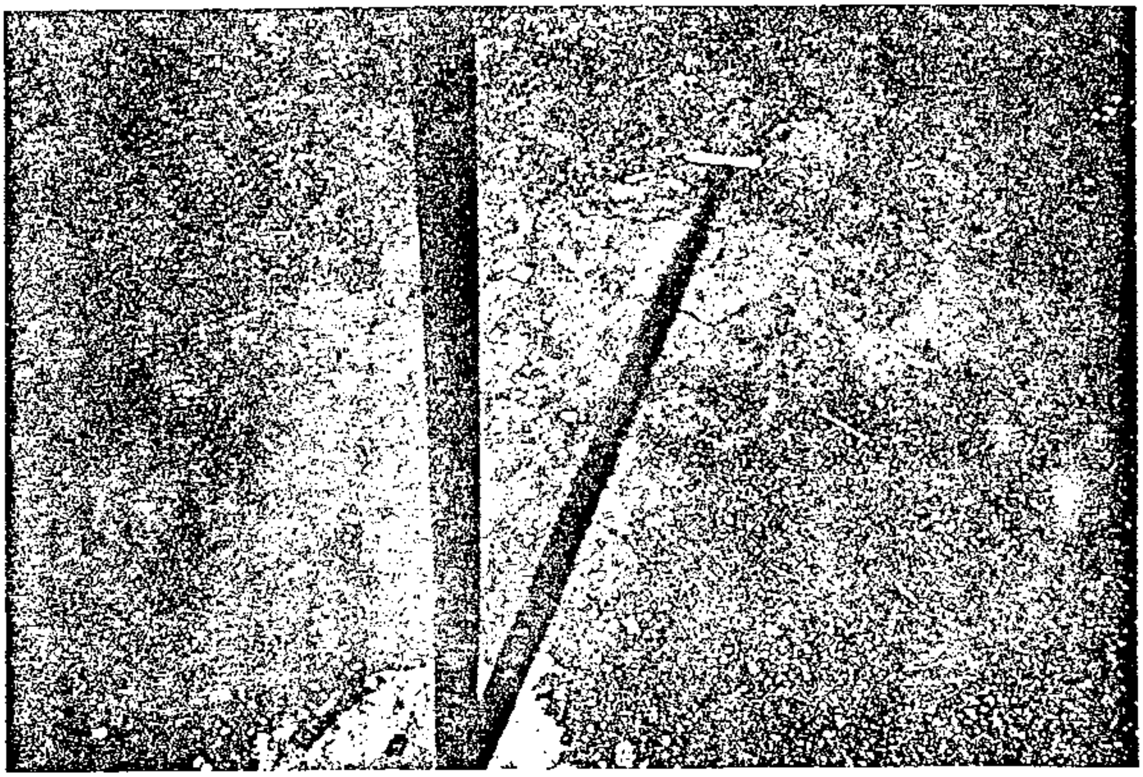
Shadows, March 23, 1992
On the way to and from
Puʻu Moaʻulaiki, showing
length and direction of shadow
before and after visit before noon.

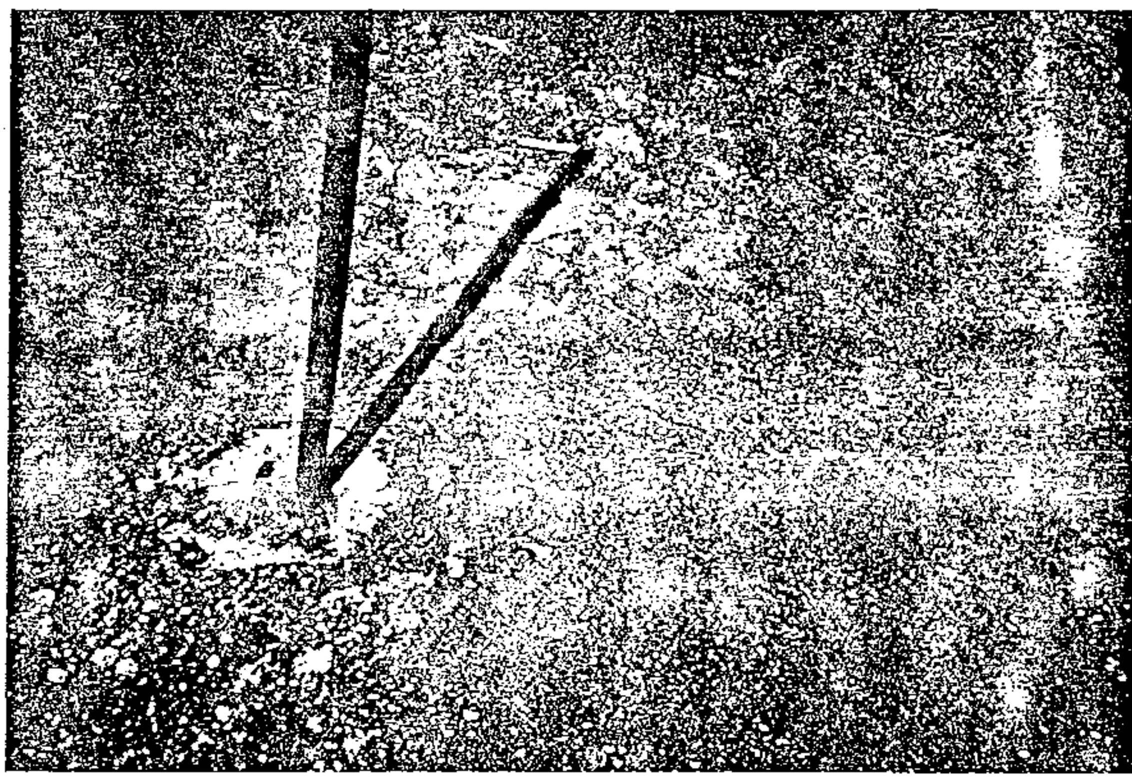


11-foot gnomon device tool
(Above)

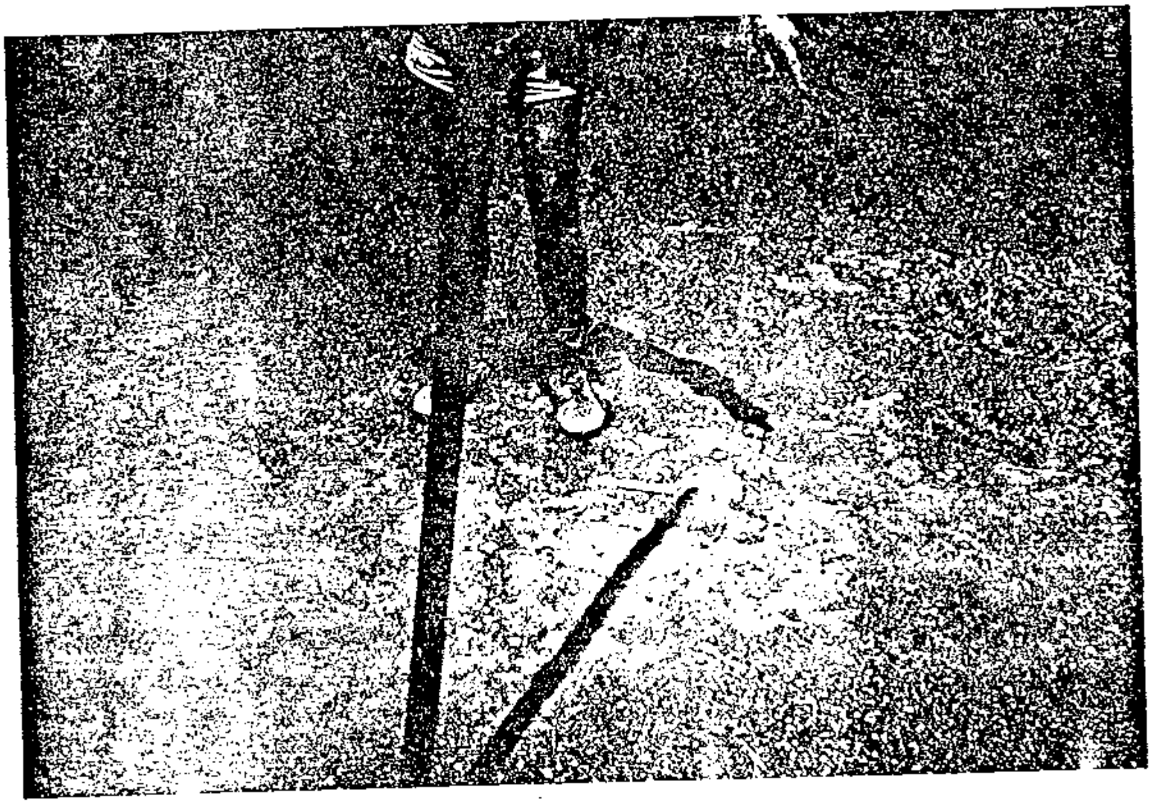
(Below)
Bone indicates position and
length of shadow at 12:20 a.m.

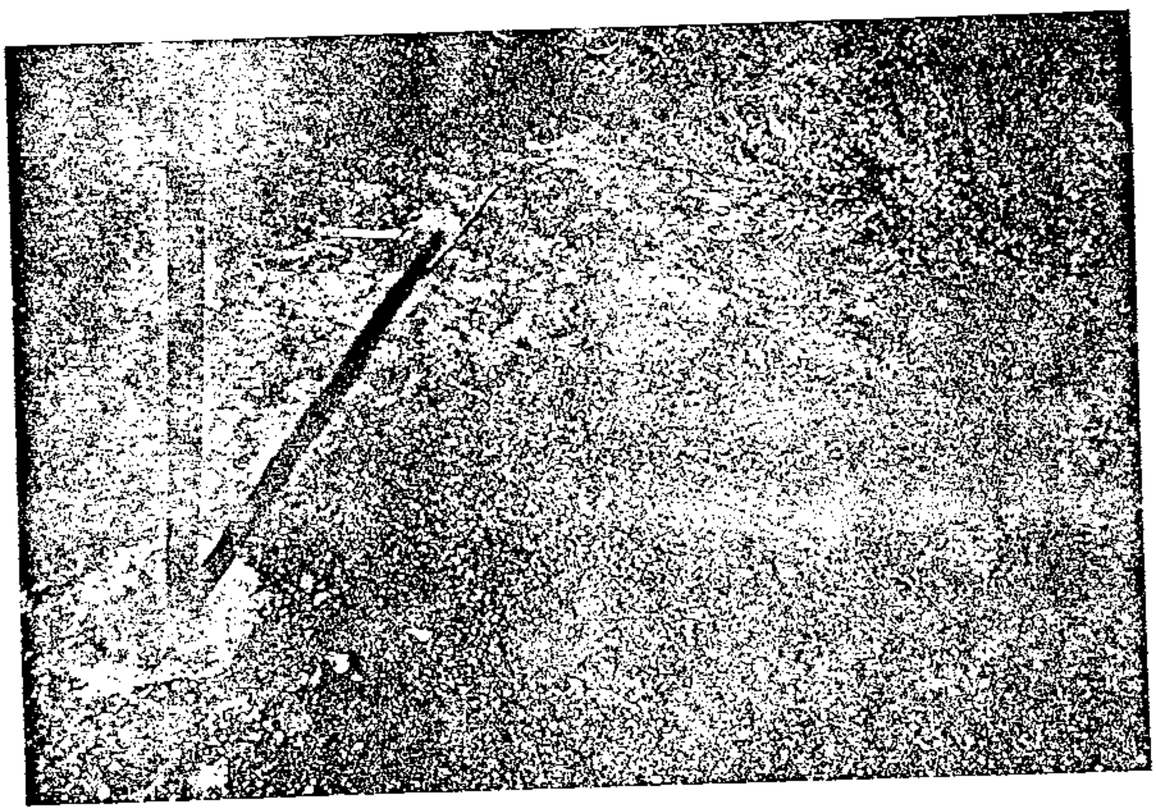
14.12



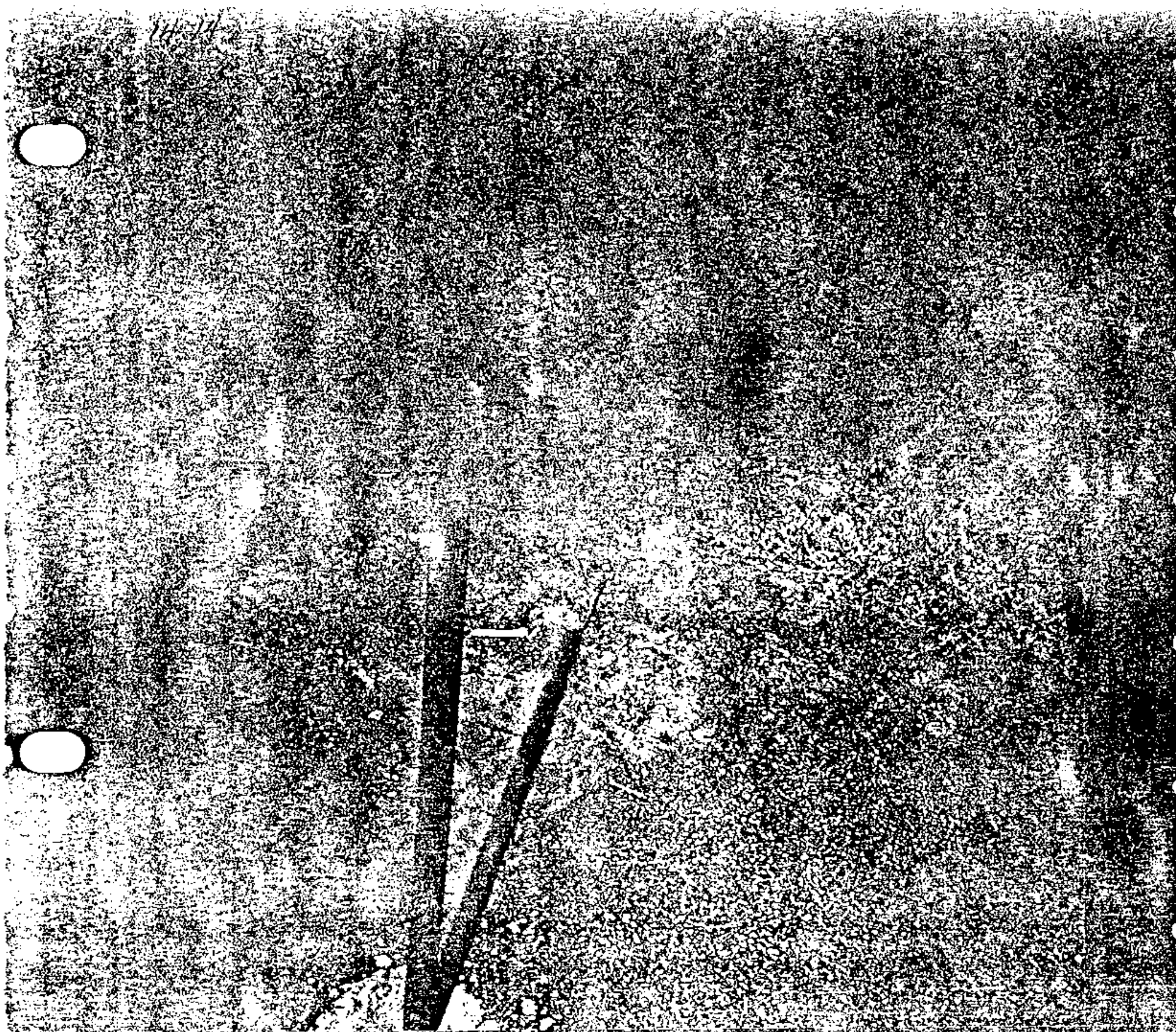


12:20 a.m. shadow line
Shadow length = 1/3 height of
the pole at 12:20 a.m.





Above + below:
Shadow moving forward
noon line north (other
shorter stick)



Shadow at noon to North 360°
has moved from the middle
of the box from 12:20 a.m to
12:35 a.m in 20 minutes.

6. CONCLUSION

There is a positive result from the combined efforts of the research field team and military group, as well as the archaeological and nature study associates within the base camp at Hanakanae'a, encouraged as well by the support of the Kaho'olawe Conveyance Commission, to launch this added component to the study of Kaho'olawe. We are very grateful to all.

I believe that the findings at Hakioawa which link the adjacent ridge to the site on the bluff [Site 348A Ku'ula Site, Hakioawa] above the Hale o Lono heiau is archaeoastronomically productive and will require archaeological study.

Aki Sinoto has offered his help with surveying, but that may detract from Pat McCoy's work at other important sites such as Pu'u Mo'iwi. It would have to be with Mr. McCoy's acquiescence that his archaeological field work encompass this new task as well.

Another team with hold-over members from this one will return at the next opportunity.

The principal investigator thanks the Kaho'olawe Conveyance Commission and the United States Navy, Air Corps and Marines for a pleaseant experience as well.

Rubellite Kawena Johnson

Rubellite Kawena Johnson
Research Consultant/Astroarchaeology

APPENDIX

Volume II

Archaeoastronomy of Kaho'olawe

, likened to a modest Stonehenge.
gh *Central and Eastern Arabia*, 2
d M. ALLAN, *Palgrave of Arabia*
e references were kindly brought to
further, A.H. MASRI, "The
Saudi Arabian Archaeology, vol.
"Saudi Arabian Archaeological
abian Archaeology, vol. 1 (1977), pp.
inary Report on the Second Phase
he Journal of Saudi Arabian Ar-
O.
thern Arabia, see W. DOSTAL, "Zur
kel, ed. E. Graf (Leiden: E.J. Brill,
of the area, see B. DOE, *Southern*

D.J. DE SOLLA PRICE, *Science Since*
1976), pp. 78–80, and the references

of the Pre-eminence of the Right,
e French), in *Right & Left*, ed. R.
pp. 239–62, especially pp. 248–53.
a are cardinally aligned, and was
tudy, he was able to recognize the
." On the orientation of the Ka'ba see
rewells *Early Muslim Architecture*,"
p. 94. The notion that the pagan
zing Jerusalem is propounded in G.
aaba . . . (Erlangen: H. Lüling, 1977),
Direction in Synagogue and Church,"
203. (Landsberger's plans showing
of plans of mosques that show the

e Hijaz towards the east, see W. BAR-
n Moscheen," *Der Islam*, vol. 18

dan. abie Occidentale," *Mélanges*
1926), pp. 37–173 (pp. 1–137 in the

eavens, see J. HENNINGER, "Über
en," *Zeitschrift für Ethnologie*, vol. 79
n de l'Arabie Centrale à la Veille de
ligion in general.
A.

Ahu a 'Umi Heiau

A Native Hawaiian Astronomical and Directional Register

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Honolulu, Hawaii 96822

BACKGROUND

IN RECENT YEARS an interest has developed in identifying native astronomical registers at various archaeological sites.[1,2] Although such registers have been reported from Oceania, none has been positively identified in Hawaii by actual alignment sightings. There is a hint of one such solstice register at Cape Kumukahi, Hawaii, in legend.[3,4]

A gap exists, then, in archaeoastronomic studies in Hawaii. The ancient Hawaiians, in spanning the Pacific Ocean during the migratory period, were seafarers who navigated confidently by the night sky.[5] They were a people who knew of the azimuthal positions of rising and setting stars, sun, moon, and planets. Not only did they search the sky for omens; they also used a farming and fishing calendar based on the cycle of the moon. Their culture reflects a knowledge of the sky. Yet, archaeologists have not found a definitive *heiau* that positively relates that knowledge.

A *heiau* is a Hawaiian temple, usually a walled enclosure resting on a paved platform (*kahua*). In Ahu a 'Umi Heiau may be found an astronomical-directional register that could provide insight into how ancient Hawaiians structured the sacred cosmos of the sky to a sacred space

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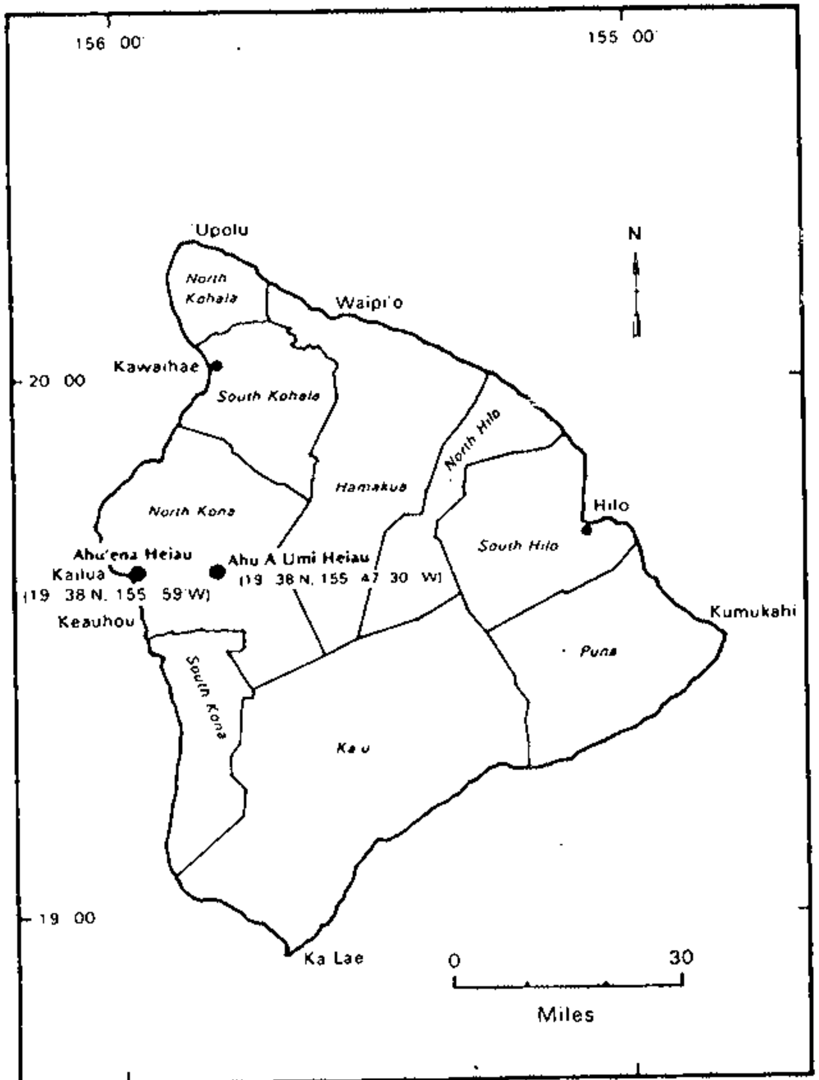


FIGURE 1. A location map of the island of Hawaii.

on earth. The Hawaiian word *ahu* means a "heaping," as of rocks, or a "gathering," as of people.

Ahu a 'Umi Heiau sits at an elevation of 1585 meters, on the high, flat saddle between the volcanoes Mauna Loa (4170 meters high) and Hualalai (2520 meters high). Mauna Kea (4205 meters high), the highest mountain in Hawaii, rises impressively to the northeast.

The *heiau's* location is at 19° 38′ N, 155° 47½′ W. It is the furthest inland and the highest of all large, precontact (i.e., pre-European discovery period) *heiaus* in the Hawaiian Islands (FIGURE 1).

Native Hawaiian tradition claims that this *heiau* is that of 'Umi, a high-ranking chief who united eight districts under his rule some five centuries ago. Another ancient legend says that, after consolidating the eight districts, 'Umi undertook a census of his newly acquired territory, which included the whole island of Hawaii.

Since the priests participated in the king's census-taking, they were responsible for setting the dates of significant ceremonial events. Census-taking was a prelude to taxation, particularly after conquest, consolidation, and reapportioning of land. The noted Hawaiian chronicler, David Malo, informs us that the heliacal rise after sunset of the Pleiades in autumn heralded the beginning of the *makahiki* festival, when taxes were collected:[6]

> The Polynesian year, as stated by Ellis, Fornander, Moerenhout and others, was regulated by the rising of the Pleiades, as the month Makali'i began when that constellation rose at sunset, i.e., about November 20.[7]

Makemson also places the beginning of the *makahiki* at the rising of the Pleiades, "late November or early December," on the "new moon *after* the first appearance in the eastern sky in the evening twilight."[8]

THE STRUCTURE OF AHU A 'UMI HEIAU

The structure of the *heiau* is a complex of three parts: (1) a central rectilinear enclosure or *enceinte* 22.8 meters long by 17.4 meters wide, (2) eight cairns, or *ahus* of stones, irregularly spaced around this central *enceinte* on the north, east, south, and west, (3) a smaller stone enclosure to the west, the walls of which are 8.83 meters (N), 7.45 meters (E), and 6.75 meters (W). The southwest side of this smaller *enceinte* with its entrance is 8.44 meters long (FIGURE 2).

In 1840, men from a United States Navy Exploring Expedition conducted the first survey of Ahu a 'Umi. The survey map showed an ar-

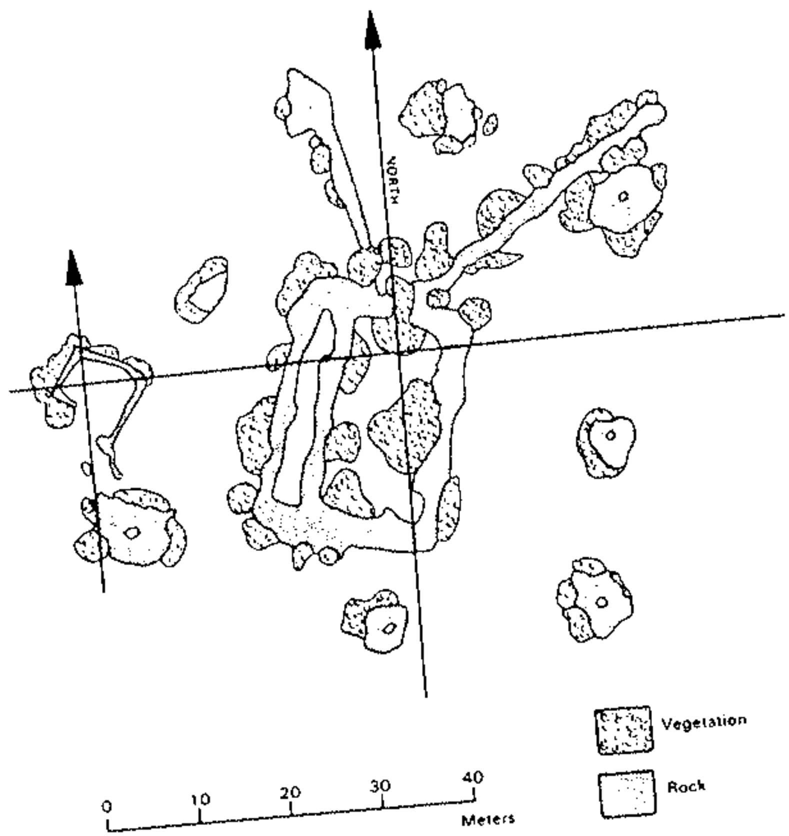


FIGURE 2. A directional and scaled baseline map of the Ahu a 'Umi Heiau complex.

rangement of cairns around a central enceinte with inaccuracies in both spacing and location.[9] The surrounding cairns were described as flattop pyramids with bases wider than the tops. These generally fit the description of astronomical platform observing sites in the Gilbert Islands:[10]

> •*Buatarawa*. A *buatarawa* was a platform built up of large stones, upon which the Gilbertese male of adult years performed the magico-religious ritual known as *te kauti*. The base of such a platform would measure from 3 to 4 feet square; its height would vary between 2 and 12 feet; its sides tapered inwards very gradually from base to summit. The summit was flat, being levelled off with fine shingle, in order to afford a sitting-place for the person performing the *kauti* ritual. A *buatarawa* was placed by preference on the eastern side of an island, but any site which commanded an eastern horizon was considered satisfactory. The ritual of *te kauti* was performed at the point of dawn, facing the sunrise.

The arresting feature of the expedition diagram, called the "Wilkes's map," is a central corridor (which does not exist today) running in and through the central *enceinte*. A ground search conducted by our archaeological field team yielded no evidence of its existence.

About a hundred years ago, stones were removed from some of the cairns to construct stonewall extensions from the northern wall outwards, probably for herding livestock into the central enclosure. Portions of the cairns and the central *enceinte* are in dismantled condition.

However, and this is important, while some cairns and walls appear to be in disarray, owing to decades of neglect in an area prone to shuddering earthquakes and, in recent times, to inadvertent vandalism through minor resetting of stones, the complex appears, on the whole, to have maintained the geometry of its arrangement and its basic form. This structural integrity is most apparent when viewed from above.

FIELD OBSERVATIONS AT 'UMI'S HEIAU

In March 1980, we took aerial photos of the *ahu*. These photographs were subsequently used to produce a map of the *heiau*. An understanding of the *heiau's* function as an astronomical register would depend upon: (1) knowing the north-south baseline, (2) having a scaled base map of the whole complex, and (3) relating the azimuthal bearing of cairns to the azimuthal positions of rising and setting stars, sun, and moon. For this we must start from the pivotal vantage point, a center.

At the summer solstice we noticed that the sun rose behind the northeast cairn (subsequently labeled "Cairn B"), from a vantage point not at the center of the *enceinte* but closer to its northern door. We then asked ourselves, If the central *enceinte* did not exist, where would the spatial center of the complex be located, based on procedures used in *heiau* construction? The arrangement of 'Umi's *heiau* suggests that it was designed according to prescribed rules for constructing a symbolic design of the cosmos on earth.

Our first task was to plot the north-south base line by taking transit sightings of Polaris, using it as our reference star. At the autumnal equinox, we noticed that the western corner junction of the smaller-outside enclosure had a pointedly true east-west orientation. An extension of a line on this orientation would intersect our north-south base

TABLE 1

Cairn	Azimuthal Reading	Associated Astronomical Feature
A	22°	
B	65°	Summer solstice sunrise Arcturus (rising) Pleiades (rising)
C	115°	Winter solstice sunrise Antares (rising)
D	150°	Canopus (rising)
E	192°	
F	245°	Winter solstice sunset Antares (setting)
G	288°	Regulus (setting)
H	349°	

line at close to a right angle. With our aerial photographs, we determined a point on the north-south base line that roughly corresponds to the spatial center of the whole complex. Realizing by now that the western enclosure's corner junction may have served as an "east-west pointer," we extended this line to that point on the north-south baseline. We posit an astronomical center, but the *heiau* must also be associated with terrestrial bearings of significance. With an accurate topographic map we plotted the bearing directions of Waipi'o Valley, Hawaii, 'Umi's birth place, and also the summits of the three surrounding high mountains transposing all these bearings onto an accurately produced base map. These were checked against an enlarged, vertical aerial photo before proceeding with the placement of our transit *in situ* to match the central point on the map. From this point, directions and scaling lengths were measured, including routine measurements of wall lengths, cairn widths, and so on. As a check on the precision on our north-south base line, we conducted a noon-shadow line experiment at the winter solstice. In this, the shadow of a pointer falls on the north-south line at local noon when the sun transits the meridian at Ahu a 'Umi.

We assigned letters to cairns starting with Cairn A east of north and working clockwise through the next seven cairns, B, C, D, E, F, G, and H. The widths of the cairns allow for approximate naked eye sightings of astronomical phenomena, assuming that astronomical observation was an intended purpose of Ahu a 'Umi's design. The results of winter solstice readings of the cairns from the center point are given in TABLE 1.

AHU A 'UMI AND THE TRADITION OF HEIAU CONSTRUCTION

We shall now look at Ahu a 'Umi from the standpoint of the tradition of *heiau* construction and use.

Hawaiian historian Samuel Kamakau points out that, in *heiau* construction, the foundation was laid down before enclosing walls were made:[11] "When the *kahua* (foundation) of the heiau was finished a stone wall was built around it, and seven terraces (anu'unu'u) made." Kamakau is talking about a terraced *heiau*, not one like Ahu a 'Umi, but it is true for both types that the design of the *heiau* was contemplated before it was laid out and the building of the walls was not attempted until the places for each of the components had been determined. Malo attests that the architect first exhibited the plans of the *heiau* on the ground to the high chief with an explanation of all its significant parts:

> "If the king, the priests and others agreed that it was best to build an entirely new luakini, the kahuna kuhi-kuhi pu'u-one was sent for. It was his function to exhibit a plan of the heiau to the king . . . the plan of which the kuhikuhi pu'u-one explained to the king; and if the king was pleased, he first made a sort of plan of the heiau on the ground and exhibited it to the king with an explanation of all its parts, so that he could see where the fence was to run, where the houses were to stand, and where was the place for the lananu'u-mamao with the idols."[12]

There are at least two categories of *heiaus*. One type is the Lono *heiau* raised to the god of peace and agriculture; the other is the Kū *heiau* for the god of war and human sacrifice. Structurally, the Kū type is usually built with a smaller companion enclosure called the Hale o Papa (House of Earth-Mother) nearby. The Lono type does not have the companion. Within the confines of a *heiau*, space is assigned to male and female. The male sides are usually north and east; the female, south and west.[12] From this description, it appears that Ahu a 'Umi *heiau* is patterned along the Kū type.

The literature reports that, in measuring distance and in enclosing space in a *heiau*, the builder used a stretching cord (*aha hele honua*, "earth-going rope") from a pivotal point to square corners and circumscribe area.[13] The limits of the *heiau* outside the walls of the Hale o Papa and main enclosure of a Kū *heiau* beyond the *papahola* borders were marked with crosses.[14] If the *aha hele honua* stretching cord was used to circumscribe the area of a rectangle, such as one of the sacred houses on the *kahua*, it seems likely that it was also used to determine the

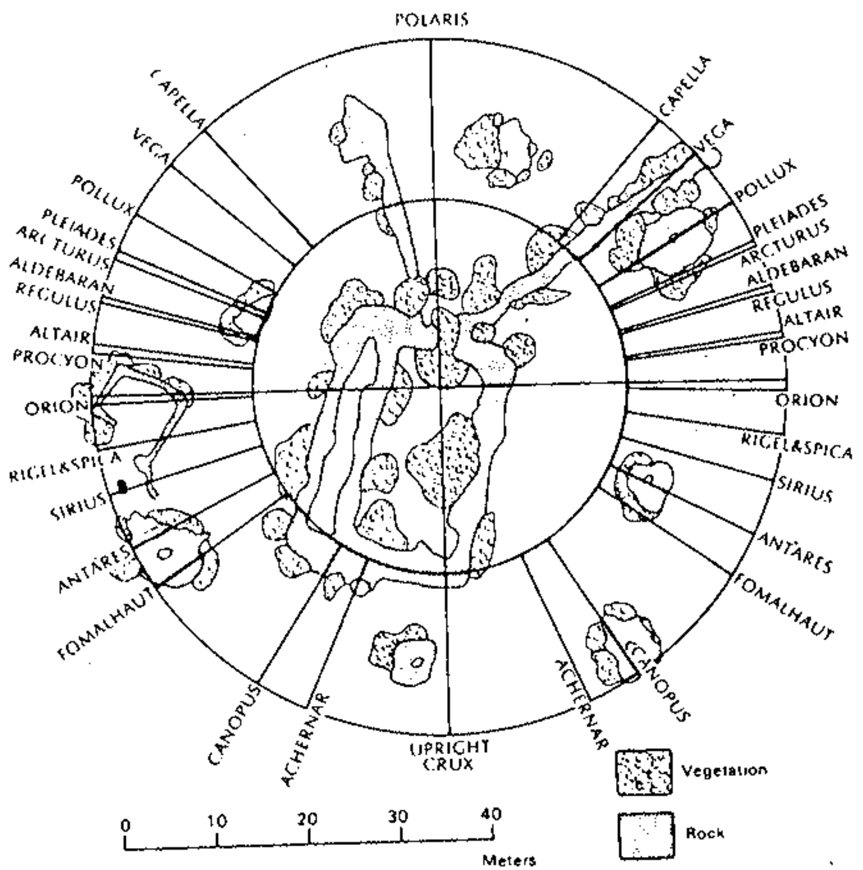


FIGURE 3. Star compass, A.D. 1500.

pivot point from the center to the *papahola* limits. Hawaiian *heiaus* are of circular as well as rectangular form.[15]

We posit that, once this spot was determined, the priest established his north-south base line by aligning the poles to Hōkūpa's (Polaris), 'Fixed-star,' and Newenewe, the upright Crux.[16] His east-west base line would then be established at the equinox, with Orion's belt (Na Kao) rising only one degree south of the point of equinoctial sunrise. This east-west line corresponds to the celestial equator, *ke alanui i ka piko o Wākea*, "the way to the navel of Wākea" (the universal Sky-Father).

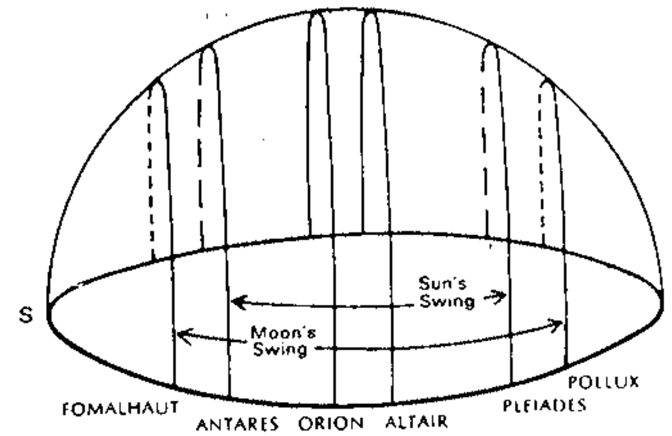


FIGURE 4. Hawaiian sky dome.

THE HAWAIIAN GOURD COMPASS-CALENDAR

Tradition also reports the existence of a so-called "gourd compass," (FIGURE 3). From the definition of this gourd, we can guess that it contains a representation of the cosmos that includes the northerly and southerly swing of the sun, the celestial equator, and the points of rising and setting navigation stars. Such a compass served as a register for the Hawaiian "tropical year of 360 days" (FIGURE 4).

The *ke alanui polohiwa a Kāne*, meaning the "black shining road of Kāne," and the *ke alanui polohiwa a Kanaloa*, meaning the "black shining road of Kanaloa," were represented by parallel lines that marked the northern and southern march of the sun. The annual motion of the sun, the northward and southward swing of the sun during the year, was described as *ke ala a ke ku'uku'u*, meaning the "pathway of the spider." It is that distance on the gourd compass between the two parallel lines. This served as a measure of time; that is, it represented 180 days, half the Hawaiian tropical year.

Thus, the gourd compass may be seen as (1) a directional guide and (2) a calendar. As a compass it provides azimuthal directions for the rising and setting of navigational stars; as a calendar it integrated the Hawaiian

tropical year with the altitudinal movements of stars across the night sky.[16] While this compass-calendar was designed to be set in a gourd, perhaps as a mnemonic device, it could also have been carried in the mind of the Hawaiian *kahuna kilo hōkū* (star-gazing priest).

The concept of the center of the earth is expressed in Hawaiian as *ka piko o ka honua*, "the navel of the earth," that of the horizon circle as *ke kukulu o ka honua*, or ambit of the circumscribed area, the "compass of the earth." Measuring with the cord was called *e ka'i i ka aha hele honua*, "to lead the earth-going cord." A circle measured by this cord would intersect lines extended toward the solstice sunrise and sunset points from a center. The line of a cord drawn or stretched between the solstice points on the circumference of the ambit represents the annual motion of the sun on the ecliptic, called the "pathway of the spider" (*ke ala a ke ku'uku'u*). This length would represent both distance and time, that is, a given distance on the ground requiring the passage of 180 sunrises or sunsets, or one-half the annual path along the ecliptic (tropical year with intercalation of about five days). A specific measured length of earth may then be identified with the measured time in the sky. From this arrangement the number of days from solstice point to solstice point could be expressed as a given distance marked on the ground or along the horizon. This length represents the "path of the spider."

THE PYTHAGOREAN TRIANGLE AND THE PATH OF THE SPIDER

A feature in some Hawaiian *heiaus* is a distinct ratio between the length and breadth of the foundation. We found that Ahu a 'Umi had a width of 17.4 meters and a length of 22.8 meters, which gives a diagonal of a right-angled triangle that accords with the proportions of the Pythagorean triangle (FIGURES 5 and 6). On this basis, we provide a theoretical representation of Ahu a 'Umi (FIGURE 7). This representation fits not only this *heiau* but other *heiaus* elsewhere (FIGURES 8 and 9). We believe that the Pythagorean ratio is one of the ratios used in the construction of *heiaus* in Hawaii.

At Ahu a 'Umi, we discovered that the distance between the extreme corner of the Hale o Papa enclosure and the central point, defined as the *piko* (navel), is related mathematically to the length of the diagonal of the main *enciente*, supporting the belief that our central point is close to the focal point for the whole complex. If we use the Hale o Papa distance as a radius and draw a circle centered on the pivot point, we would find

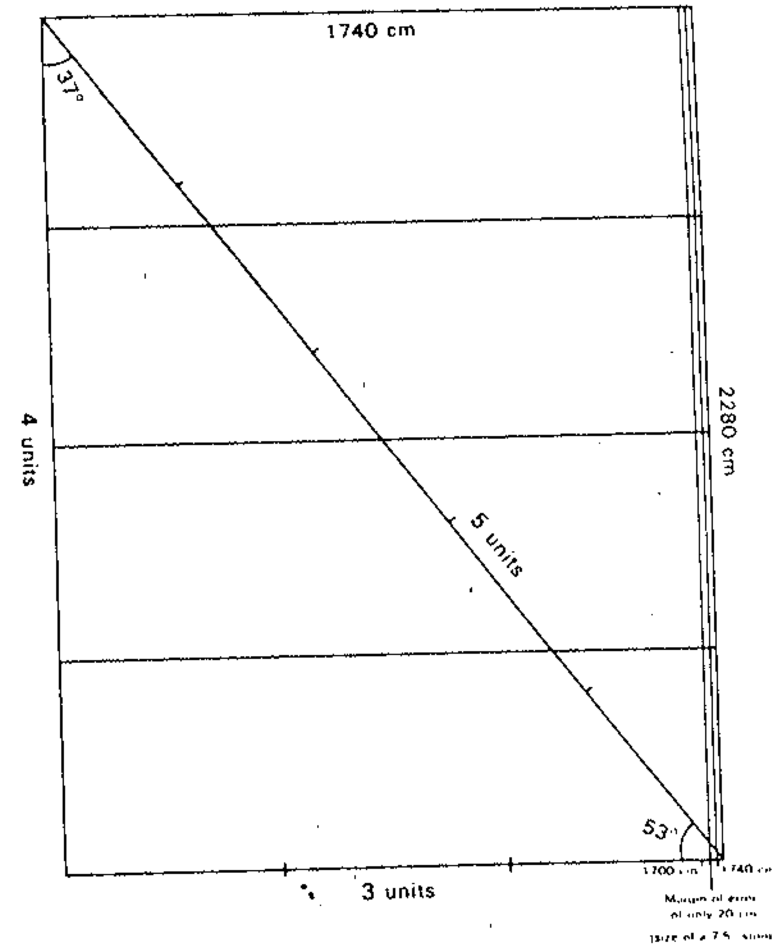


FIGURE 5. Kahua dimensions of the interior section of Amu a 'Umi based on field measurements.

that the straight line joining the solstice points on this circle would be the "path of the spider," representing 180 days of the Hawaiian tropical year (FIGURE 10).

We further discovered that the length of the "path of the spider" matches the diagonal length of the main *enceinte*, the five-unit side of the Pythagorean triangle.

The relationship between the radius from the Hale o Papa structure to

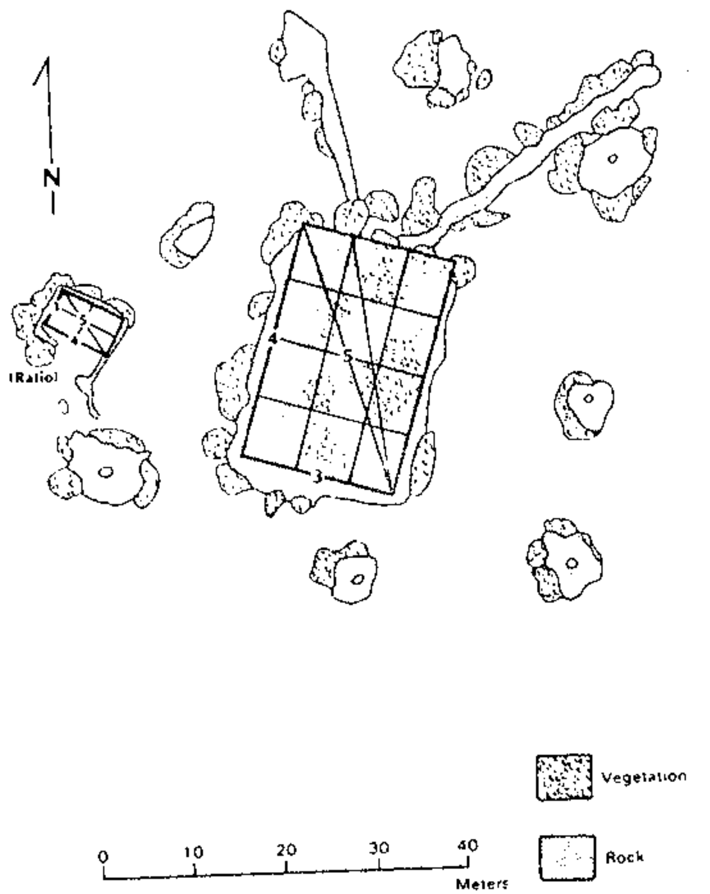
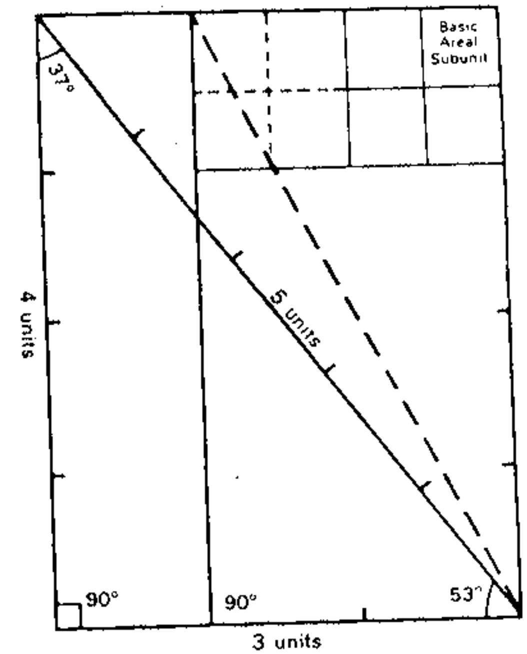


FIGURE 6. The outlined area is represented by a clearer geometric model on the reverse side.

the pivot point, the length of the main *enceinte*, and the ground length representing 180 days of the Hawaiian tropical year can be expressed mathematically.

At Ahu a 'Umi, if the radius of the circle of the earth is assigned a value of one, and the angle subtending the solstice points is θ, then the mathematical relationship can be expressed as:

$$2 \sin \theta = \text{the chord joining the solstice points on the circle}$$



The Pythagoras Theorem: "The square of the hypotenuse is equal to the sum of the squares of the other two sides."

$$(5 \text{ units})^2 = (4 \text{ units})^2 + (3 \text{ units})^2$$
$$25 = 16 + 9$$

FIGURE 7. A possible theoretical arrangement of Ahu a 'Umi Heiau.

Expressed in another way:

$$2 \sin \theta = \frac{\textit{ke ala a ke ku'uku'u}}{\text{radius of } \textit{ke kukulu o ka honua}}$$

$$2 \sin \theta = \frac{\text{the path of the spider}}{\text{radius of the compass of the earth}}$$

This relationship is trigonometric and important to the understanding of *heiau* construction. The diagonal length of the *heiau* is set by the length of the "path of the spider," which, in turn, is determined by the size of the "compass of the earth," which is set by the radius extending from the "navel of the earth" to the edge of the "house of Papa, earth-

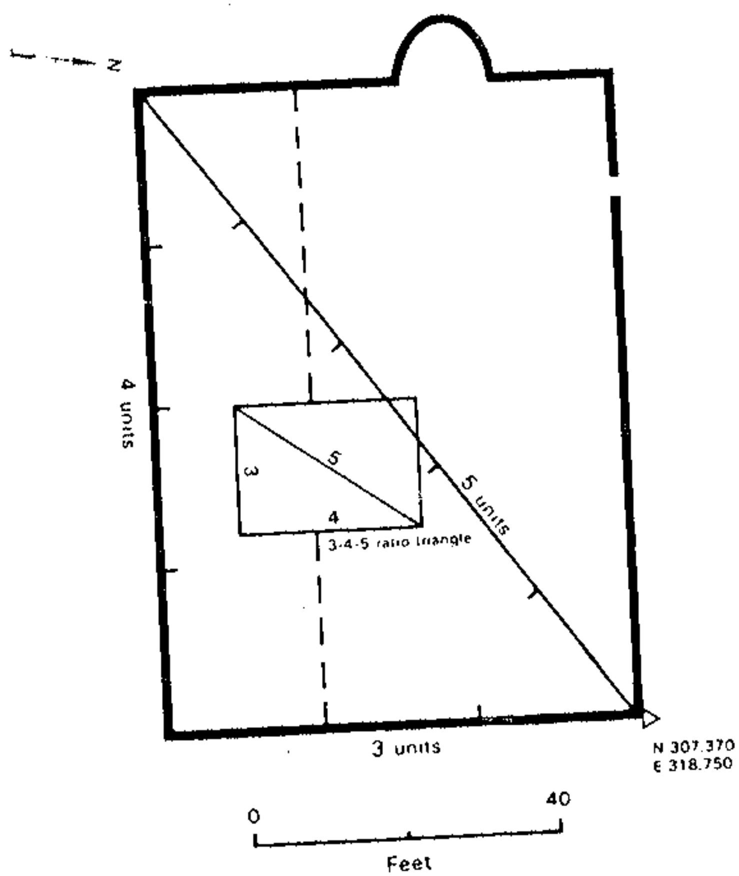


FIGURE 8. Kahua dimensions of a "house site" (*heiau*?), the proportions of which are similar to those of Ahu a 'Umi Heiau.

mother." These indigenous terms are concepts of dimension expressed in the symbolism of profane space made sacred by relating sky to earth, which is a rationalization of cosmology.

If the Pythagorean five-unit side is used as a measure, then the Hawaiian tropical half-year of 180 days may be partitioned into five single units of 36 days each on the diagonal of 'Umi's *heiau*:

3 units × 36 days = 108 days
4 units × 36 days = 144 days
5 units × 36 days = 180 days

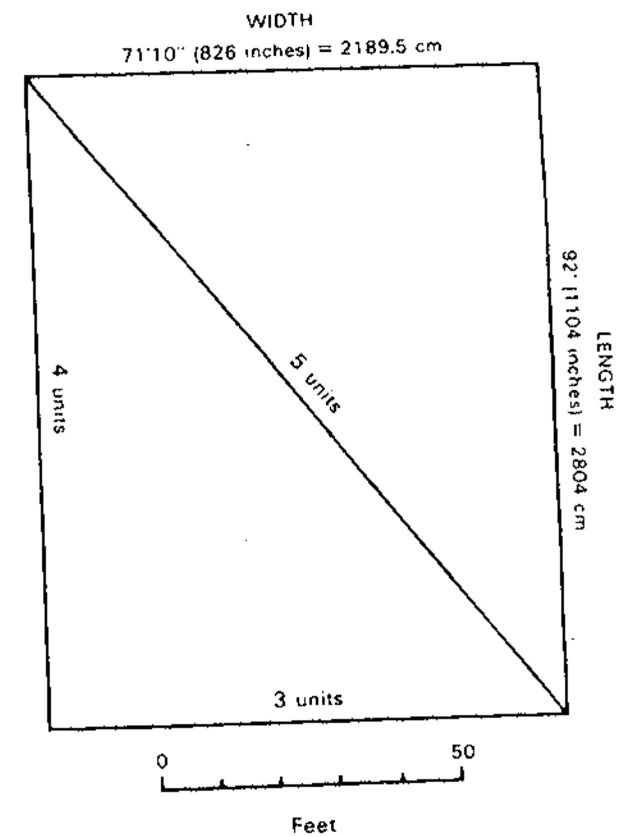


FIGURE 9. Kahua dimensions of Ahu a 'Umi Heiau based on the Wilkes map of 1840.

The squares (areas) of these sides would correspondingly be:

9 units × 36 days = 324 days
16 units × 36 days = 576 days
25 units × 36 days = 900 days

The sum total of these would be 1800 days, or 10 Hawaiian tropical half years, or 5 Hawaiian tropical years of 360 days.

Thus, symbolically, the *kahua* of the central *enciente* of 'Umi's *heiau* is represented by time. In the mind-set of the astronomer priest, area is equated with time, space with days.

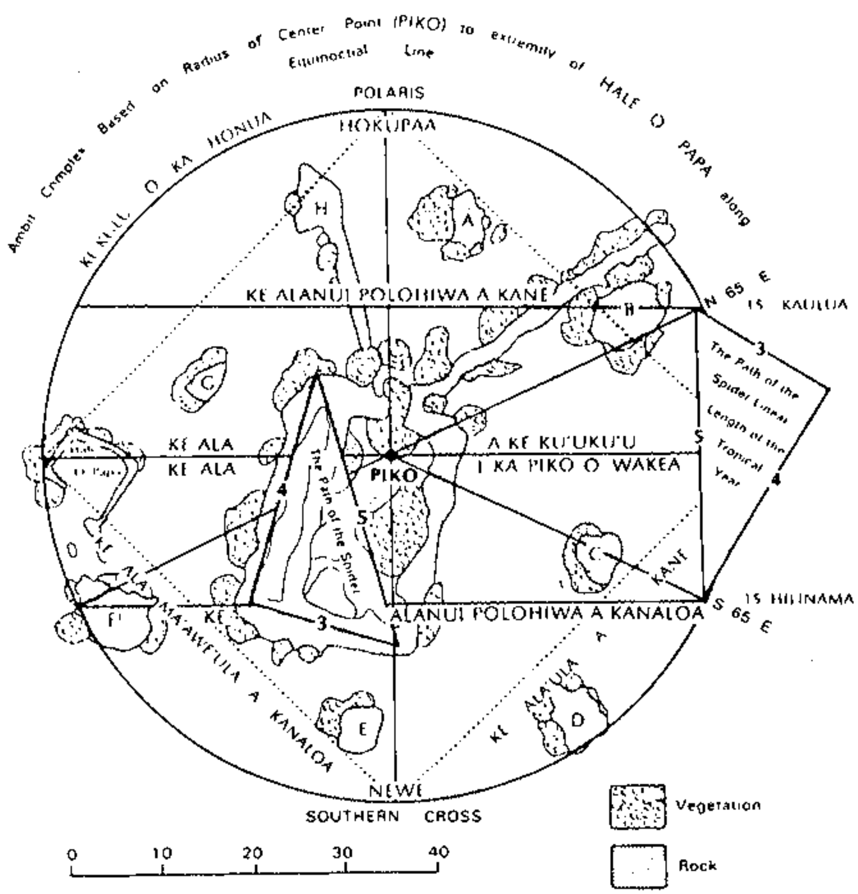


FIGURE 10. The path of the spider.

AHU A 'UMI HEIAU AS A DIRECTIONAL REGISTER

A particular feature of this *heiau* is that its main axis is not oriented towards Polaris, near true north, but tilted to east of north. This tilt is closely oriented to the azimuthal rising of Dubhe, the rim star of the Big Dipper (which is called, in Hawaiian, *Na Hiku*—the seven). The rising point of Dubhe accords with the direction of Waipi'o Valley, the birthplace of 'Umi. We suggest that this may be a reason for the tilt of the main *enceinte*, as this "Royal Star" can be viewed through the opening into the main enclosure. If this is the case, and more study is needed, then the entrance is directionally and astronomically aligned to the positions of the Big Dipper around Polaris nightly and throughout the year.

There are other orientations that, we suggest, are significant. Cairns B and C on the sunrise side and Cairns E and G on the sunset side accommodate the most northerly and southerly extents of the moon's swing as well as those of its minimum nodes. From the pivot point, this most northerly extent of moonrise aligns with the summit of Mauna Kea. Cairn B in particular, the largest and the best existing *ahu*, appears to be a significant ritual platform for the observation of (1) the summer solstice rising sun, (2) the heliacal rise of the Pleiades, which is associated with the great *makahiki* season, and (3) the rise of Arcturus, the navigational zenith star of Hawaii. (FIGURE 11).

One is awed by the genius of the architect. He had to arrange the geometry of Ahu a 'Umi Heiau to accommodate significances in solar, lunar, stellar, and terrestrial orientations. We believe that he succeeded in this effort. Hōkūloa, the Morning Star, Venus, was the most prominent feature in the early morning sky on that winter solstice morning. The secret of Venus's role at Ahu a 'Umi escapes us. Perhaps only the *kahuna kilo* knew.

SUMMARY

This article is only a preliminary note to interested observers in ethnoastronomy and archeoastronomy that the geometry of the Ahu a 'Umi Heiau on the island of Hawaii is arranged so as to align, astronomically and directionally, with the moon, the sun, the stars, and an imposing mountain top, as well as the birthplace of the Hawaiian high chief for whom the *heiau* was constructed. This arrangement assumes meaning when placed in the context of the astronomical knowledge of the ancient Hawaiians embodied in the Hawaiian star compass-calendar and the ancient rituals associated with the cosmography of terrestrial and celestial space.

If the gourd-compass diagram of instruction by Keneakaho'owaha, considered in the light of this study of Ahu a 'Umi, may be given credence, then the results may reflect the inference of Makemson that

> there is ample evidence that the Polynesians visualized a zone of about 50° wide symmetrical about the celestial equator, and bounded on the north by a parallel of declination through the June solstice and the Pleiades and on

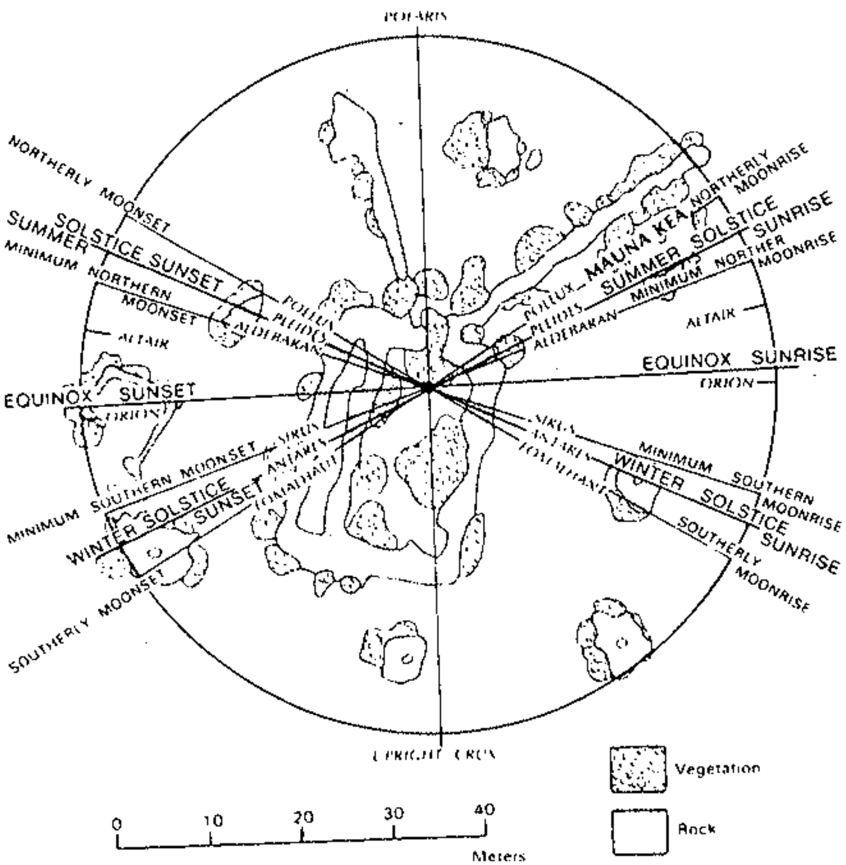


Figure 11. Solar-lunar-stellar associations.

the south by a corresponding parallel through the December solstice and Antares. Through this wide belt of sky moved the Sun, Moon, and planets. Within this zone were all the stars which were suspended in the zeniths of the islands of tropical Polynesia. In it were situated most of the stars used for guiding the canoes on ocean voyages. Outside it were the stars of space or "foreign" stars as previously described in a quotation from the Hawaiian scholar, Kamakau [i.e., Kanaeakaho'owaha].[17]

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17. Makemson,* p. 113.

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Astronomy, *Cosmovisión*, and Ideology in Pre-Hispanic Mesoamerica

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The intent of this article is to contribute a few considerations from the fields of ethnohistory and anthropology to the interdisciplinary approach of this volume. The point of departure for this investigation is the study of Aztec calendar festivals and their relation to society in Central Mexico on the eve of the Spanish Conquest, a study in which ritual is analyzed as a social phenomenon.

We will deal with certain aspects of pre-Hispanic astronomy from the point of view of its close interrelation with the calendrical system and with *cosmovisión*, relating these different elements to each other and analyzing them in terms of their ideological significance. The concept of ideology that will be used in this approach establishes the link between *cosmovisión* on the one hand, and social reality and economic and political structure on the other. Methodologically speaking, I will interpret ethnohistorical, archaeological, and astronomical data in terms of anthropological theory.

We also might indicate, in reference to the question of terminology, that by *cosmovisión* – a term borrowed from the common Spanish usage – we understand the structured view in which the ancient Mesoamericans combined their notions of cosmology into a systematic whole, while *ideology* will be used in a specific way denoting the basic approach of this paper. It implies a distinction between "objective social reality" and the "explanation" that the ancient Mesoamericans gave of that reality. Ideology is a system of symbolic representation, and its most important social function is to legitimize and justify the existing order of

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society. In this sense, ideology creates a "false conscience" of reality in societies, like pre-Hispanic Mexico, that have experienced the rise of social classes and the state.

Although it has long been a well-known fact that astronomy was highly developed in ancient American civilization, its serious scientific study is a latecomer to pre-Hispanic studies. These studies have registered great advances during the last decade, and it is only just to mention in this context that the most important single contribution is due to the work of Anthony Aveni, to whom we also owe the organization of this conference. His latest book, *Skywatchers of Ancient Mexico*, represents the culmination of many years of research, including the editing of two other books on archaeoastronomy.[1] These books established the study of American archaeoastronomy as a legitimate separate field of research, closely related to archaeology and ethnohistory. I would even say that, in Mesoamerican studies in general, the most interesting innovative results that have come to light during the past years have been in those aspects of field research related to pre-Hispanic agricultural systems, particularly in the Maya area, on the one hand, and in archaeoastronomy on the other. The conclusions reached in archaeoastronomy are based on fieldwork and can be checked by the methods of astronomical science. This circumstance adds a very important dimension to this young discipline; further stimulating results can be expected in the future.[2]

In this essay I assume that the reader is familiar with the general background of pre-Hispanic astronomy, as well as the basic structure of the calendar system.[3] This permits me to concentrate on certain specific points relating to the important dates of the solar year, in order to examine the interrelationship that existed between solar observation, the structure of the calendar, and the calendar festivals. As I have indicated above, the specific case studied concerns Aztec society and *cosmovisión* on the eve of the Spanish Conquest; however, I believe that the implications of my analysis are of a more general nature and might be extended to other regions and time-periods of Mesoamerica as well.

THE CALENDAR

The Mesoamerican calendar was one of the purest sun calendars known among peoples of antiquity. Its basic structure was the solar year of 360 + 5 days. It was combined with a ritual calendar of 260 days; it is not clear whether this cycle was based on the observation of nature or

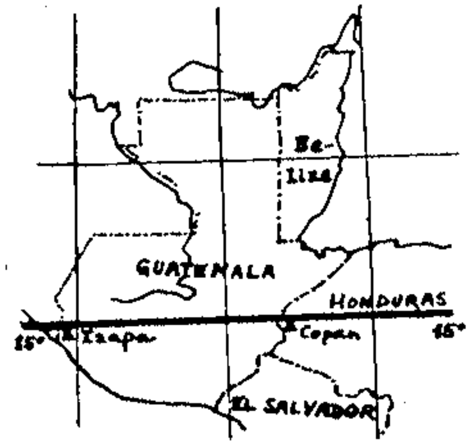

FIGURE 1. The latitude of 15° N: Guatemala and Honduras (Izapa and Copán).

resulted from a combination of the ritual cycles of 13 and 20 days. Its natural basis might have been the period between the two passages of the sun through the zenith in the geographical latitude (approx. 15°N) of the ancient Maya centers of Izapa and Copán (FIGURE 1).[4] Thus, the most plausible natural explanation of this cycle might also be a solar one.

The combination of the cycles of 365 and 260 days resulted in a larger unit of 52 years, the Calendar Round, which was the basic unit of Mesoamerican chronology, in its so-called Short Count (*xiuhmolpilli*, or "Bundle of Years"). At its end, the Aztecs celebrated a big festival, called the "Binding of the Years." In it, they kindled New Fire, which symbolized that the world would continue for another 52-year period. The celebration of this festival coincided with the date the Pleiades passed the meridian at midnight (November 18). We will return later to the interesting question of the annual cycle of this constellation.

While the ancient Maya developed a sophisticated knowledge of the moon's course, which they registered in complex tables of lunations and eclipses,[5] no record of such calculations survived the Conquest in Central Mexico. Although we must assume a certain familiarity with these computations all over Mesoamerica, they seem not to have been integrated into the structure of the calendrical system, but, rather, to have remained property of a restricted priestly class. In the Central Highlands this subject requires considerably more research than it has so far received.

The Maya were also quite knowledgable about the Venus cycle and

brought it into tune with the solar year. Every 8 years, the solar year of 365 days coincided with the cycle of Venus of 584 days, a circumstance that received great attention in terms of the calendar as well as of ritual.

It is a fact that 16th century ethnohistorical sources from Central Mexico do not reveal, by themselves, the importance of solar events. The Spanish friars who wrote these chronicles were neither particularly interested in nor aware of astronomical phenomena, and the indigenous sources (pictographic documents and sources transcribed in Nahuatl) also do not refer explicitly to these events; their language is highly symbolic and hides astronomical implications behind metaphors. The key to deeper penetation of the enigma of Mesoamerican archaeoastronomy has emerged recently from a systematic study of the orientation of Mesoamerican architecture.

The coordination of space and time in Mesoamerican *cosmovisión* found its expression in the orientation of pyramids and architectural complexes. These structures are in many cases oriented in relation to the ocurrence of sunrise or sunset on specific days of the solar cycle. Taking up the sporadic attempts at measurements undertaken earlier by a number of authors,[6] A. Aveni and H. Hartung have, in the past ten years, made systematic field measurements of the orientation of archaeological complexes with the surveyor's transit, which are now complete enough to permit one to draw statistical conclusions. These data constitute a firm basis for any further analysis.[7] Franz Tichy, on the other hand, has combined the investigation of this type of measurements with the study of the cultural landscape as it can still be observed today in the Central Highlands of Mexico. Tichy's interdisciplinary approach, combining astronomy with cultural geography and ethnohistory, has yielded a series of interesting insights into the ancient Mexican calendar and its relation to *cosmovisión*. Some of his intriguing hypotheses still need further testing.[8]

The aforementioned studies have established the fact that numerous pre-Hispanic pyramids and buildings were oriented towards the direction of sunrise or sunset on the main dates of the sun's yearly cycle, i.e., the days of the solstices, the equinoxes, and the zenith. Thus, it was the objective existence of these orientations in archaeological complexes, observable today, that drew attention to the importance of the solar dates corresponding to these orientations and that has stimulated further investigations into the cosmological implications of these facts.

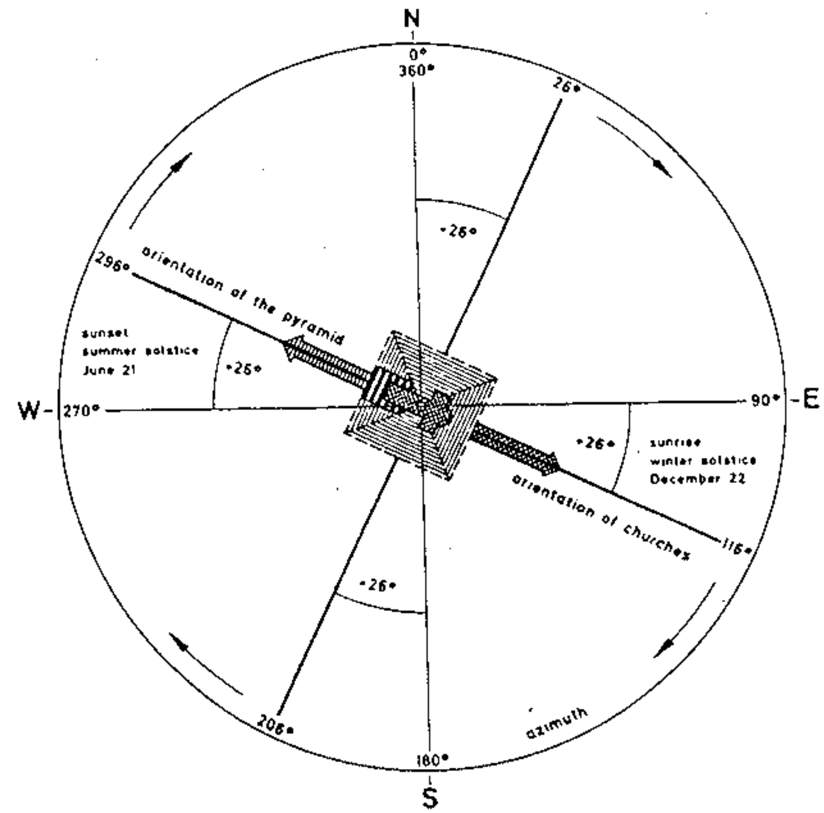

FIGURE 2. The orientation of the pyramid of Cholula in relation to the solstices (the exact angle is 294° 45'). (From Tichy,[8] "Ordnung," by permission of the author.)

THE SOLSTICES

It appears that, among solar phenomena, the ancient Mexicans attributed the greatest importance to the solstices, particularly the summer solstice.

The orientation of the great pyramid at Cholula with 294° 45' corresponds to sunset on the summer solstice (21 June), or to sunrise on the winter solstice (22 December).[9] The priest who stood in front of the temple at the summit of the pyramid performing certain rites could observe sunset on the day of summer solstice at a point on the horizon deter-

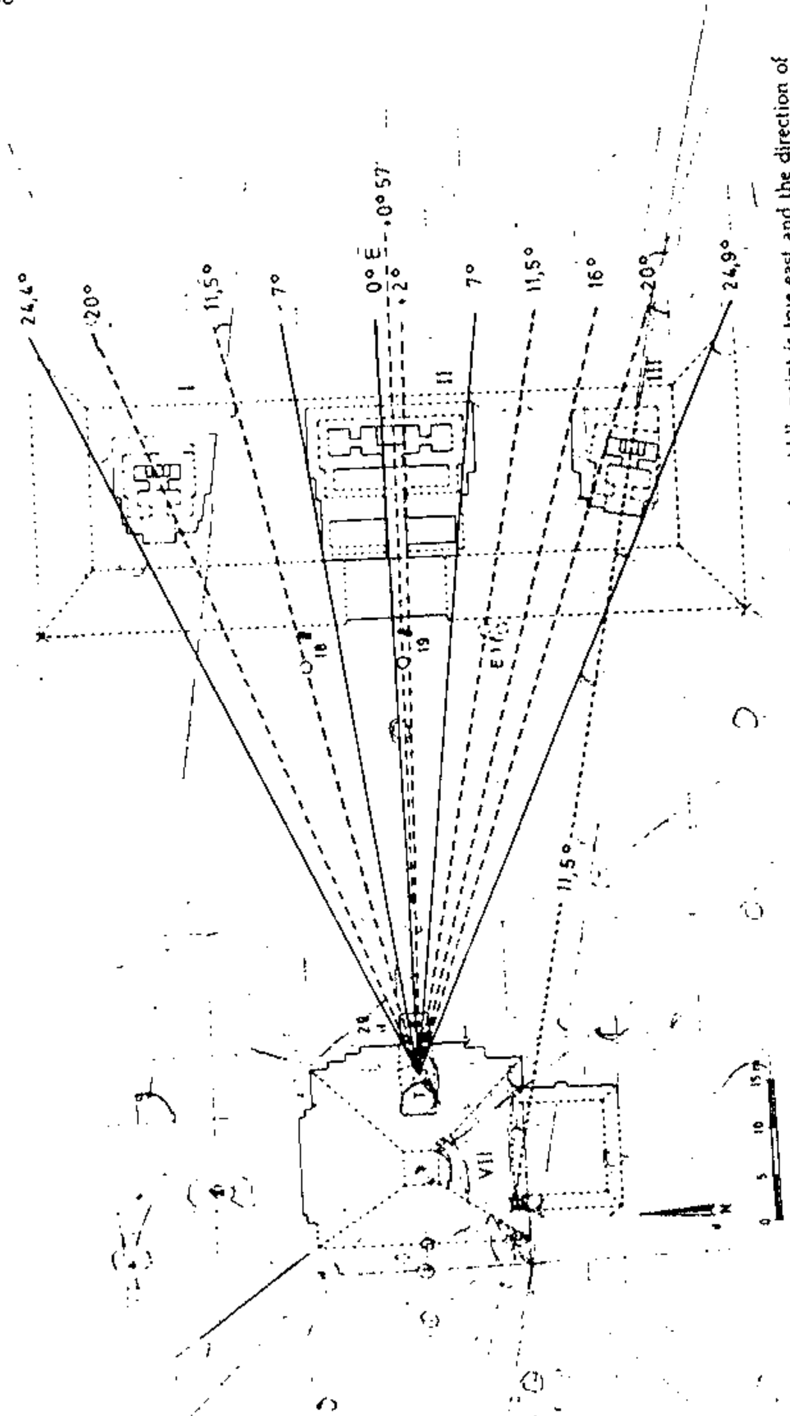

FIGURE 3. Building E at Uaxactún. The two extreme points are the solsticial angles; the middle point is true east and the direction of midyear (0° 57'). (From Tichy,[8] "Ordnung," by permission of the author.)

mined by the axis of the temple and the pyramid, an event that repeated itself every year on the same day (FIGURE 2).[10,11]

The easiest way to fix the solstice is by observing the annual movement of the sun on a straight line on the eastern or western horizon. Seen from an observatory at a certain distance, the equinoxes mark the middle point (0°) on the horizontal line, while the solstices determine the two extreme points, with symmetrical angles of approximately 24.5° (for latitudes 15°–19°N), the so-called solsticial points. An observatory of this kind was found at the Maya site of Uaxactún (building E) and dates from pre-Classic times (FIGURE 3).[12] According to Tichy, another one existed at Xochicalco, in combination with the architectural complex C + D (FIGURE 4).[13] R. Fuson points out that some 18 observatories of this kind have been discovered in the Maya area.[14] One of these, the astronomical observatory at Xochicalco, a chimney built into an artificial subterranean chamber, is constructed in such a way that it captures a beam of sunlight at noon on the day of the summer solstice (FIGURE 5).

By means of the four solsticial points (including the sunrise as well as the sunset positions), one can draw a diagram, which, in pre-Hispanic times, was a highly important symbolical representation and can be found on numerous archaeological pieces. U. Köhler derives the symbolism of the Aztec day sign *olin* ("movement", "path") from this solsticial diagram and proves that its origin was an Olmec model from pre-Classic times (FIGURE 6).[15] According to Girard, these representations are called "cosmic diagrams;" he describes their ritual use among the Chorti of modern Honduras.[16] Still surviving ethnographic data have been reported for other Indian groups, particularly in the Maya area.[17]

THE EQUINOXES

The cardinal directions of east and west were fundamental in Mesoamerican *cosmovisión*. The east was the point of reference for the other directions. Yet these two directions, corresponding to an azimuth of 90° for 21 March and an azimuth of 270° for 23 September respectively, are extremely rare in the orientation of pre-Hispanic buildings. The reason seems to lie in the geographical conditions of Mesoamerica; there, the equinoxes do not constitute as outstanding a climatological phenomenon as they do, e.g., in Europe. In Central Mexico, the difference in the length of the day between 21 June and 22 December is only 2 h 20 min, in contrast to 8 h 30 min in the European latitude of 50°.[18]

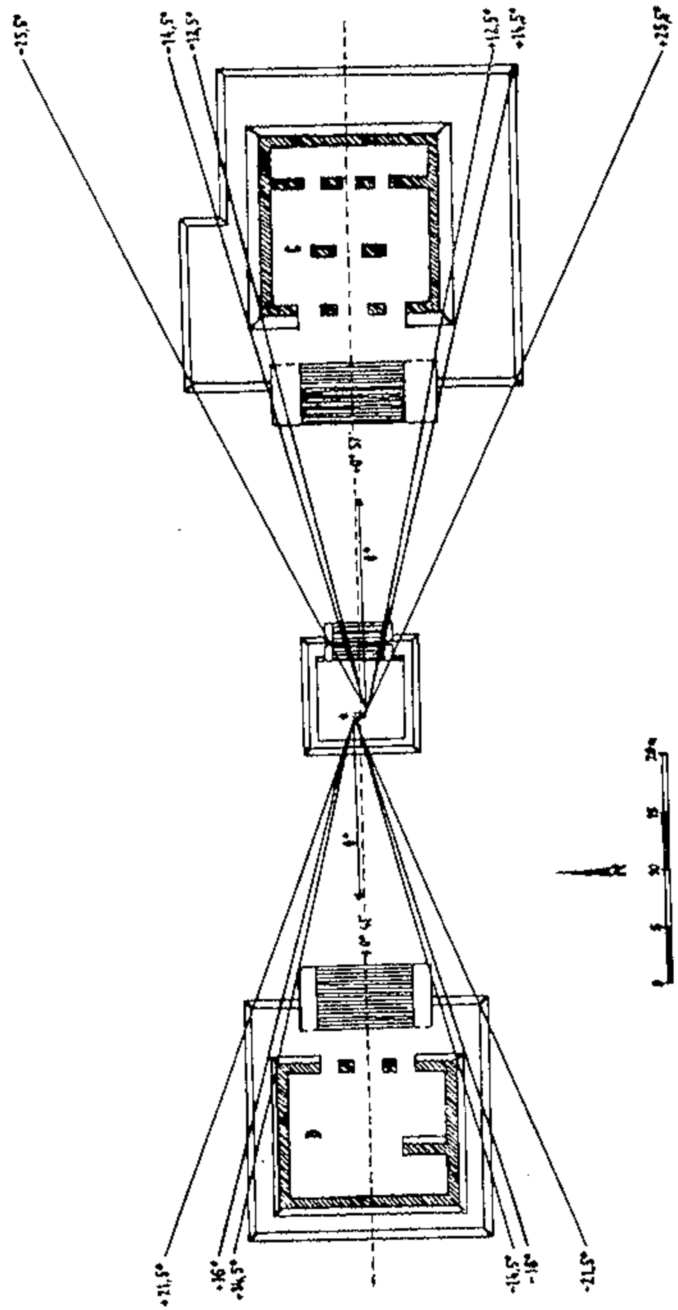

Figure 4. Pyramids C and D at Xochicalco. The most interesting angles are 25.5°, sunrise on 22 December, the winter solstice; 21.5°, sunset shortly before the zenith passages on 15 May and 29 July; and 0° 57', which marks the days that divided the year into equal halves. The diagram is from Tichy,[8] "Calendario;" measurements by Aveni, Jan. 1977, and Tichy, 1975 and 1977.

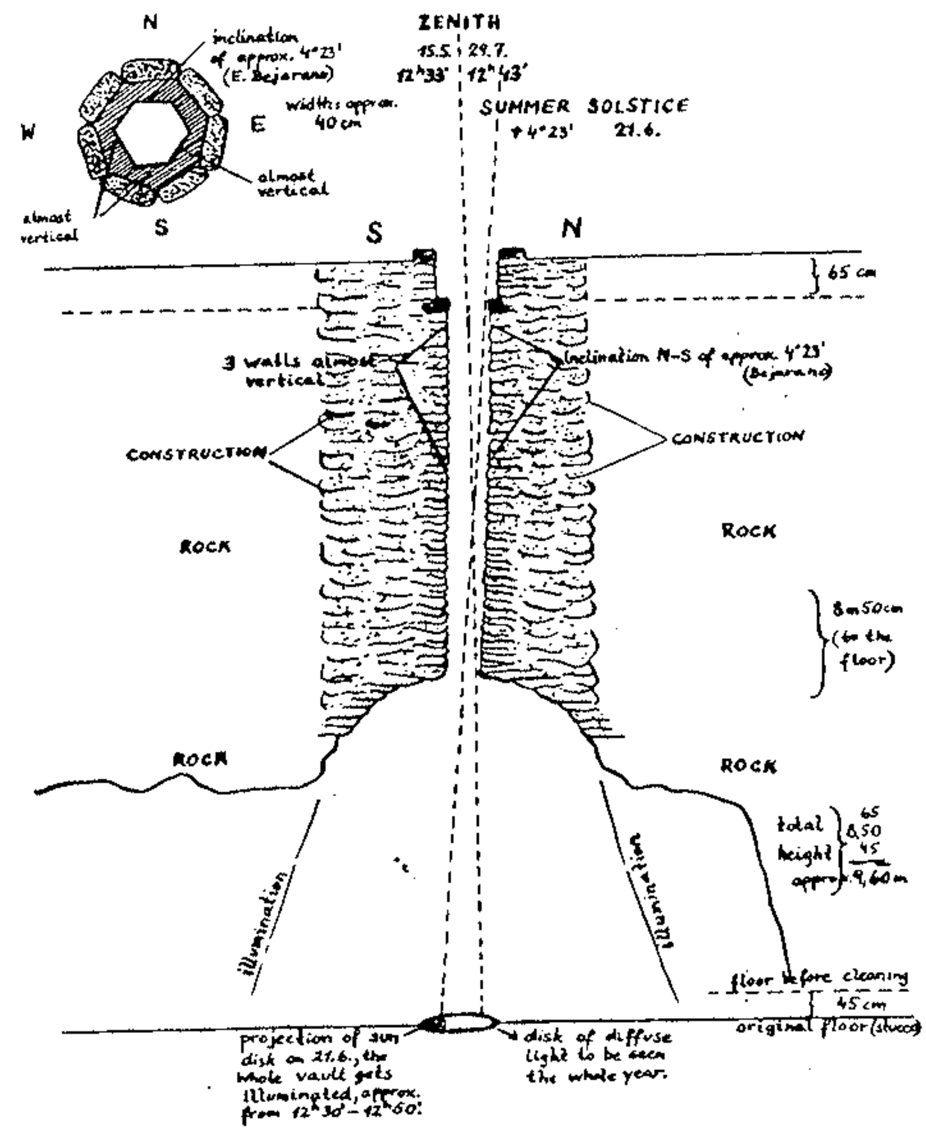

Figure 5. The astronomical observatory at Xochicalco. The latitude of Xochicalco is 18° 46' N. The drawing is based on Tichy,[8] "Festkalender," and personal communication from E. Bejarano, director of the Centro Regional del INAH, Morelos, to the author; 21 June 1980.

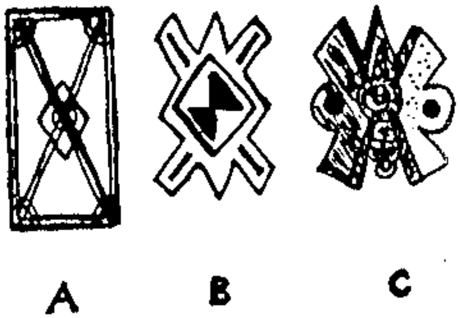

FIGURE 6. Cosmic diagrams: (A) La Venta, (B) Teotihuacan, and (C) the Aztec day sign *olin*. (From Köhler.[15]).

Tichy points out that, instead, the ancient Mexicans seem to have attributed more importance to the days that divided the year into equal halves, i.e., March 24 and September 20, which account for a division in which the winter half is 8 days shorter than the summer half, than to the equinoxes. To the former date corresponds the angle of 0°57′ deviation E to S, which, according to Tichy, can be found in the axes of the calendrical buildings of Uaxactún and Xochicalco (FIGURES 3, 4).[19]

THE ZENITH PASSAGES

The geographical latitude of Mesoamerica offers one the possibility of observing the two passages of the sun through the zenith in its annual movement between the equator and the Tropic of Cancer (lat. 23°26′ N), the point it reaches on the day of the summer solstice.[20] Between the two zenith passages, the sun moves to the north of the respective latitude of the zenith, an astronomical fact that is reflected in Aztec mythology in the concept that the sun enters the Mictlan, the abode of the dead situated to the north, during *Toxcatl*, the month of the first zenith passage.[21] This observation, which is impossible to make in latitudes north of the tropic, provides the cultures situated between the tropics with certain calendrical advantages, which have not yet been sufficiently explored in all their many dimensions.

The zenith passage of the sun is not only important insofar as the observation of that heavenly body is concerned, but the climatological phenomenon of the rainy season also depends on it, as well. The first passage of the sun through the zenith announces in Mesoamerica that the rains will start soon, which, in turn, is the necessary condition to begin the planting of maize. This interrelationship also found an expression in

myth and ritual in ceremonies related to maize and water. We will return to this point later, since it is fundamental to the understanding of the intimate association that existed between astronomical observation, climatological phenomena, agriculture, and ritual.

On the other hand, the zenith passages were also highly relevant in calendrical terms, since they provide a way to check the correspondence of the calendar and the solar year twice a year. It is easier to observe the zenith than the solstices or equinoxes since, at the latter dates, the sun's position changes only very little from one day to the other, and the difference in its movement is hardly visible.[22]

Observations of the zenith passage could be made in vertical tubes built into pre-Hispanic archaeological complexes like the one in Building P of Monte Alban (FIGURE 7)[23] or the artificial subterranean chimney forming part of the central precinct of Xochicalco.[24] Interestingly enough, the observatory at Xochicalco not only makes it possible to observe the

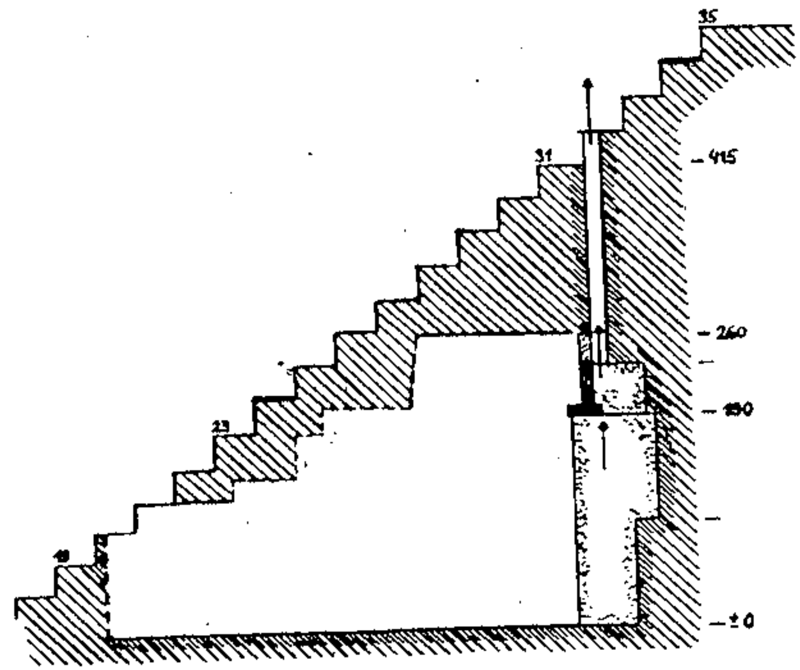

FIGURE 7. The zenith tube at Monte Alban, Building P. (Diagram by Hartung, by permission of the University of Texas Press; see Aveni,[1] *Skywatchers*, figure 85a.)

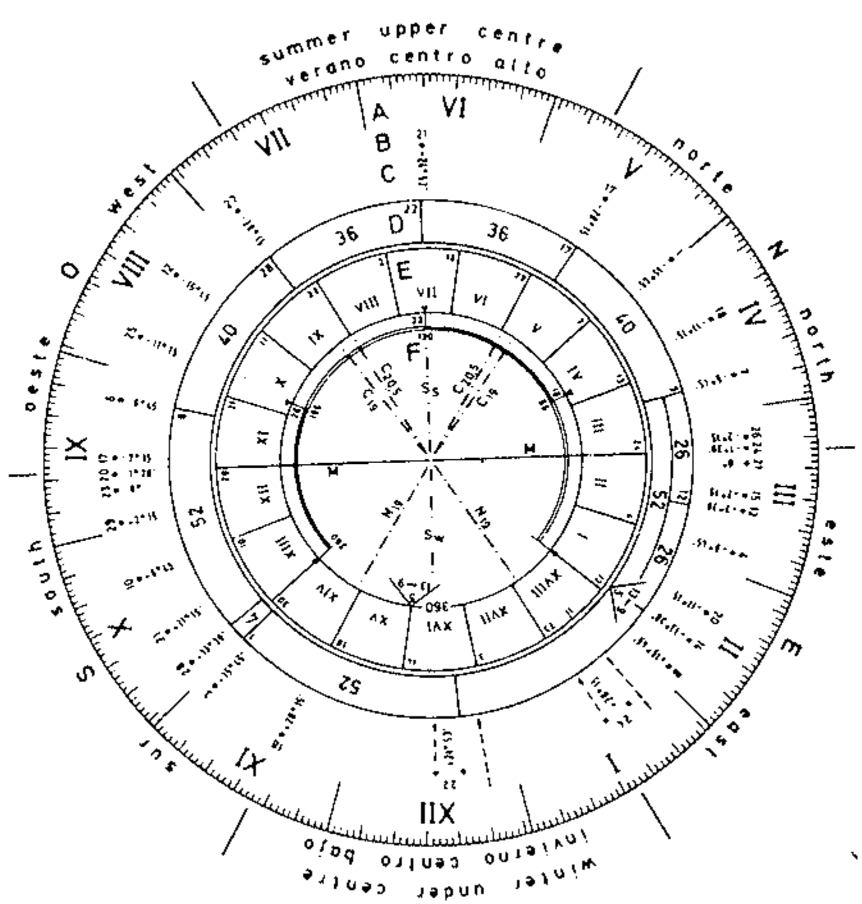

FIGURE 8. Tichy's calendar correlation and the orientation of pre-Hispanic buildings. (Diagram by Tichy, 16 Dec. 1977, by permission of the author.) A: Gregorian calendar 1975, B: days with specific directions of sunrise and sunset. C: axial deviation of pyramids, negative angles of sunrise in summer from east to north, positive angles in winter from east to south, D: "fixed *tonalpohualli*," or a solar calendar with 260 days plus 100 days and 5 days "*nemontemi*," divided into unequal periods, E: "Calendario Mexica," with 360 plus 5 days, 18 periods of 20 days and 5 *nemontemi* (9 to 13 December). The *nemontemi* are usually placed before I *Atlcahualo*, which begins on 12 February. This date for the beginning of the year agrees with Sahagún. The six groups of 60-day periods coincide with the six quarters of the universe, F: *Tonalpohualli* with 260 days, divided into four periods of 65 days or twenty thirteen day weeks. S_s and S_w: summer and winter solstices, C_{19} and $C_{20.5}$: zenith passages of the sun at latitudes 19° and 20.5° N, M: midyear days, 24 March and 20 September.

zenith passage, but its main orientation seems to be towards the summer solstice (FIGURE 5).[25] The latter construction also permits one to observe that, during the period between the two zenith passages, the sun moves to the north, while its beam of light (or shadow) will be projected to the south.

Observatories of this kind could serve to determine the true length of the tropical year, i.e., to observe that, every four years, one additional day had elapsed when the date of the zenith passage occurred. This method, which has recently been suggested by Tichy,[26] might give a clue as to how the ancient Mexicans brought the vague year of 365 days, which was a mathematical necessity within their calendrical system, into correspondence with the true solar year. There must have existed some pragmatic method of correlating mathematical cycles and solar and climatological phenomena, otherwise the calendar festivals would have fallen out of tune with the seasonal cycle.[27] Yet, an agricultural calendar that, in the practice of daily life, did not correspond to the seasons would have been useless in a society whose basic sustenance was agriculture.

In the context of these studies, Tichy has worked out a fixed correlation for the Aztec calendar. This correlation draws upon numerous elements derived from the orientation of buildings, solar dates, and aspects of the internal symmetry of the calendar, which I cannot, for lack of space, discuss in any greater detail; in general terms, Tichy's results confirm the correlation given by Sahagún, according to which the month of I *Atlcahualo* began on February 12 (FIGURE 8).[28] Only on the basis of a fixed correlation is it possible to analyze the astronomical content of the calendar festivals. Naturally, I am aware of the fact that there still remain many unresolved problems related to the correlation question.[29]

THE CEREMONIES

CALENDAR FESTIVALS, WORSHIP OF THE SUN, AND AGRICULTURE

So far, we have discussed the coordination of time and space as expressed in the orientation of buildings, which reflected solar observation and calendrical practice. The religious and social dimension of the calendar system was ritual. We are particularly fortunate in the case of Aztec ritual on the eve of the Spanish conquest, since we have elaborate descriptions of the 18 monthly festivals by Spanish chroniclers as well as several texts in Nahuatl.

One major festival was celebrated during each of the 18 months of 20

days. Besides these great festivals, minor celebrations and ceremonies took place, creating a ritual structure that ran throughout the whole year and was closely connected to seasonal and agricultural cycles, as well as to social activities. Within the complex yearly structure of ceremonies, a specific structure referring to the sun cult is clearly recognizable. However, the solar symbolism is embedded in the symbolism of deities and ceremonies, and is also related to the social groups that participated in these festivals.

The first passage of the sun through the zenith corresponded in the latitude of Tenochtitlan to 17 May, and coincided with the Aztec festival of V *Toxcatl* dedicated to the great gods, Tezcatlipoca and Huitzilopochtli, whose worship was the obligation of the ruling class. Several authors have considered *Toxcatl* the most important annual festival, as well as the first month of the year.[30] The second zenith passage corresponded in Tenochtitlan to 27 July and to the month of IX *Miccailhuitontli-Tlaxochimaco,* when the Aztecs worshipped the god of the underworld, Mictlantecuhtli, and the deceased who had departed to his abode. They also brought offerings of flowers to their patron god Huitzilopochtli (FIGURE 9).

These offerings to the dead—which also took place during the earlier month of *Toxcatl*—seem to convey the indigenous belief that, between its two zenithal passages (May and July), the sun entered the Mictlan, the abode of the dead situated to the north. In fact, as we have pointed out before, in Tenochtitlan the sun passed to the north of the geographical latitude during this period (FIGURE 9).[31]

The summer solstice coincided with *Tecuilhuitontli*. The two months VII *Tecuihuitontli* and VIII *Huey tecuilhuitl,* "the small and great festival of the lords," contained numerous elements that indicated the solar cult in relation to the cult of maize. They were also the most important festivals of the year for the ruling class; these ceremonies expressed, in a symbolic way, the function of the supreme ruler to look after the well-being of his subjects, including the poor of Tenochtitlan.[32]

The winter solstice corresponded to the month of XVI *Atemoztli,* when dogs were sacrificed to the sun in order to help it in its voyage across the river of the underworld.[33] The very name of the month, *Atemoztli,* might be understood as "Descent to the Water," meaning the descent of the sun to the waters of the underworld.[34] The month preceding *Atemoztli* was XV *Panquetzaliztli;* on its last day, the Aztecs celebrated the festival of the birth of Huitzilopochtli, which is considered

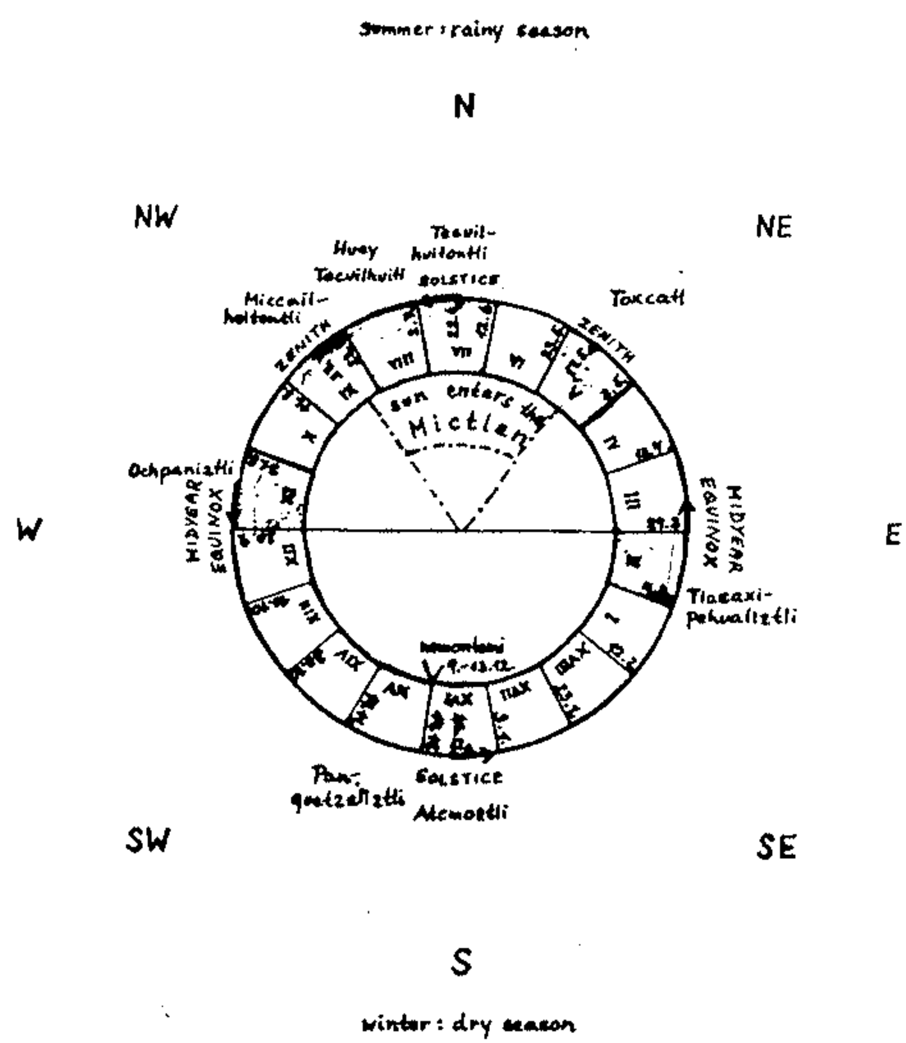

FIGURE 9. The solar cycle of Aztec festivals. Sequence of the diagram: counterclockwise, E-N-W-S. (Correlation by Tichy, author's diagram, 1981.)

to have been their "national" fiesta. It should be kept in mind that their patron god Huitzilopochtli was a solar deity.

Finally, we must mention II *Tlacaxipehualiztli* and XI *Ochpaniztli*, the two months in which fell the equinoxes, as well as the days that astronomically divided the year into equal halves (March 24 and September 20) (FIGURE 9). Both festivals were extremely rich in symbolic and dramatic elements and were, in certain ways, analogous. Their main gods, Xipe and Toci (male and female, respectively), were sacrificed by flaying and their ceremonies were intimately related to fertility and agriculture, as well as warfare. Their bloodthirsty worship was a duty of the warrior caste.[35]

The symbolism of the festivals we have mentioned, as well as the variety of gods, rites, and symbolic elements implicated in them, indicates the complexity of the subject. The correspondence between astronomical phenomena and Aztec rites was not a direct one, since it was the result of a long historical process. The origins of this process go back to the very beginnings of Mesoamerican civilization; historical documentation, however, is practically absent for these early periods.

In the course of the evolution of this correspondence, observational contents and practical requirements of the ceremonies became embedded in numerous layers of symbolism that came to acquire manifold and sometimes contradictory meanings. Yet it is valid to say that the basic structure of the ritual calendar was derived from a combination of solar observation and the needs of the agricultural cycle. A fundamental concern of ritual was with rain and fertility, as is to be expected of a culture that derived its sustenance from agriculture. The natural environment of Mesoamerica was characterized by extreme climatololgical and geographical conditions. During the dry season, there was a constant lack of water, while, during the rainy season, the waters could be dangerous in their excess. Thus, the obsession with rain and water in Mesoamerican religion had a direct material basis. This cult had become, among the Aztecs, the concern of the priests and the peasants, while the nobles and warriors participated in warlike cults with a different mythological content (like the worship of Xipe, Huitzilopochtli, Tezcatlipoca, etc.). Interestingly enough, the festivals with the most outspoken ideological content, in which the mission of the warriors and Aztec rulers was glorified, proclaiming their aspiration to political domination, were precisely those festivals related to the sun cult.

In the structure of festivals dedicated to the sun, we find that the cult of the great deities, and the cult of the dead and the underworld, were in-

timately related to warfare. At the same time, these ceremonies contained explicit references to the cult of maize and fertility. Thus, warfare, fertility rites, the solar cult, and the cult of the dead were conceptually associated in the ideology of the Aztec state cult. Another important point is that this ideology as well as participation in these ceremonies were basically the concern of the ruling class.

THE NEW FIRE CEREMONY

THE CULT OF THE PLEIADES AND THE SUN

The New Fire Ceremony was intimately related to the cult of the Pleiades as well as the solar cult and marked an important point in the intricate structure of the calendrical system. Every 52 years, as one of their large calendar cycles approached its end, the Aztecs believed that there existed an imminent danger that the world might come to a standstill. They then celebrated the festival of the "Binding of the Years." New Fire was kindled in the breast of a sacrificial victim to symbolize the beginning of a new calendrical cycle and the triumph over the dangers of destruction. This festival took place during the middle of November, at the time of the year when the Pleiades passed the meridian at midnight and were clearly visible during the whole night.

A closer analysis of the annual cycle of the Pleiades, which I have undertaken in a different study,[36] reveals not only that they were an extremely important constellation all over the Americas – including North and South American tribal areas as well as the Andean civilization and Mesoamerica – but also that, in the latitude of Mesoamerica, their calendrical importance in relation to the solar cycle was extraordinary. Their annual cycle must have appeared to the pre-Hispanic observer as a "course contrary to the sun" (TABLE 1). Their heliacal rising took place at the end of May after they had disappeared from sight for approximately four weeks. May is precisely the month of the first zenithal passage of the sun. Half a year later, during the month of November, the Pleiades are brightly visible during the whole night, passing the meridian at midnight. Thus there existed a certain "opposite symmetry" between the course of the sun and that of the Pleiades. The zenith passage of the Pleiades took place when the sun was situated at its nadir, i.e., during the month of November. Naturally, one has to take into account the fact that the zenith is the only date in the solar cycle that varies from one region to another; but perhaps it is precisely this fact that explains the importance

TABLE 1[37]

THE CYCLE OF THE PLEIADES: YEAR 1500 A.D. – LATITUDE 21° N

26 April–29 May (3 May–4 June) *Period of invisibility*	The Pleiades are not visible. During this period, the first passage of the sun through the zenith occurs at Tenochtitlan (17 May).
29 May (4 June) *Heliacal rising (dawn)* (The Pleiades rise in the east at dawn, before sunrise, in parallel with the sun.)	This is the first day on which the Pleiades rise in the east before dawn. From this date on they rise earlier than the sun each day until November. During this period they are, at first, seen only at dawn; progressively, they can be seen during a longer span of the night until dawn.
1 November (7 November) *Heliacal setting (dawn)* (The Pleiades set in the west before dawn and rise after sunset in the east, contrary to the sun.)	The Pleiades appear after sunset in the east. Between 1 and 18 November they can be seen from sunset (rising in the east) to sunrise (setting in the west), i.e., during this period they are visible throughout the night.
16 November (22 November) *Zenith at midnight*	The Pleiades pass the zenith at midnight. This date coincides with the nadir of the sun at Tenochtitlan (six months after 17 May).
18 November (25 November) *Heliacal rising (dusk)* (The Pleiades rise in the east after sunset and set in the west before dawn, contrary to the sun.)	The Pleiades begin to set in the west before dawn. From November to January, they are visible from sunset (rising in the east) until sometime before dawn (setting in the west).
26 April (3 May) *Heliacal setting (dusk)* (The Pleiades set after sunset in the west, in parallel with the sun.)	From 18 November until 26 April the Pleiades set earlier each day until, on 26 April, they set in the west before sunset. This means that they disappear from sight for a period of approximately one month, until, on 29 May, they begin to rise again in the east at dawn.

NOTE: The 1980 dates are given in parentheses. All these dates only have an approximate validity; variations in atmospheric and topographical conditions can cause a difference of several days.

that XV *Panquetzaliztli* (corresponding to November) and V *Toxcatl* (corresponding to May) acquired in the Valley of Mexico, two festivals in which the solar symbolism played a particularly significant part in the ceremonies.

The importance of these observations lies in the fact that, up to now, very little was known about the existence of the concept of the nadir in Mesoamerica. Yet we do know that this concept played an important role in the Andean region, as recent studies by T. Zuidema,[38] G. Urton,[39] and A. Aveni[40] have demonstrated. To the Incas, this date symbolized the dualism of the vertical-antivertical axis that was fundamental to their *cosmovisión*, a tradition that still survives in parts of the Andean region today.

Another circumstance worth mentioning in relation to the Pleiades is their close association to the rains and, indirectly, to the fertility of crops. The disappearance of the Pleiades from the night sky at the end of April was interpreted as a sign that the sun would soon reach the zenith and, also, that the rains would start soon. During the months of April and May, the planting of maize still takes place all over Mesoamerica; its precise timing varies according to the altitude and ecological conditions of each region. While, in the Maya area of Southeastern Mexico and Guatemala, the zenith passage of the sun coincides in the first days of May exactly with the sowing season and the beginning of the rains, the coincidence is not quite as close in Central Mexico. On the other hand, the sun's position at nadir during November coincides not only with the zenith passage of the Pleiades but also with the beginning of the dry season all over Mexico. During the latter part of the year, the sun is more dominant in the sky than during the rainy season. This fact seems to be reflected in the important mythical relation the sun had with the Aztec months of November and December, symbolized in the sun's birth during the festival of *Panquetzaliztli*, and its passage through the river of the underworld during *Atemoztli*, the month of the winter solstice.[41]

ASTRONOMY, *COSMOVISIÓN*, AND THE STRUCTURING PRINCIPLES OF THE UNIVERSE

In the preceding pages we have tried to illustrate the intimate connection that existed between certain astronomical observations, the structure of the Mesoamerican calendar, and the Aztec monthly ceremonies. The examples we have given show the complexity of the matter. Nevertheless, it seems possible to draw two kinds of conclusions: (1) On the one hand,

we can demonstrate the observational basis of the ritual calendar; its basic structure was derived from solar observation and was combined with the observation of certain other astronomical phenomena. Its practical utility derived from its link to seasonal cycles, as well as to social activities. The division of the year into the dry and the rainy season is recognizable in Aztec ritual, as is a reference to the different cycles of rainfall and irrigation agriculture.[42] (2) However, in this paper we are not so much interested in exploring the multiple dimensions of the cult itself – this I have done in other studies[43] – rather, we want to put the emphasis on the particular mental and social processes by which astronomical observations became immersed in myth and ritual, thus leaving behind the terrain of "objective" scientific knowledge. In this sense, the cult system is a good example, since one of the main objectives of pre-Hispanic astronomy was to express its observations in mythical terms and, thus, to provide the basis for the execution of rites and sacrifices.

In pre-Hispanic astronomy we find an intimate relationship between scientific observation and mythical thought. To achieve the "predictability" of natural phenomena is a fundamental goal of modern science. This was also a goal of intellectual effort among the ancient Mesoamericans. Nevertheless, there are certain fundamental differences. One of the questions arising from the concrete material is, by which specific mental processes did scientific observation transform itself into mythical thinking? To what extent did they achieve the prediction of those natural phenomena which they wanted to control, and why did this endeavor transform itself at a certain point into myth, ritual, and ideology?

With respect to the "applicability" of observations, we have seen that they could be used to predict astronomical and climatological phenomena. Nevertheless, there was more to it than that. Since cosmos and society were conceived as a unity in ancient Mesoamerica, the purpose was to learn about the laws of nature, not only to discover them, but to regulate social life as well. This conception is fundamentally different from that of the modern scientific mentality. From this particular nexus was derived the importance of astronomy and calendrics within ideology. We are dealing here with a complex process. Since natural laws have been discovered, it is possible to make correct predictions at many points. In addition, these regularities and the recurrence of the phenomena discovered are characterized by internal mathematical relations. This fact increases the "predictability" of natural phenomena, yet it does not mean that, in all cases, an exhaustive objective explanation had been found for them.

It is necessary to distinguish between the "discovery" of phenomena, their regularities, and natural laws, and the "explanations" that are given for these phenomena. In ancient Mesoamerica, the conclusions drawn from observed processes were often of a nonscientific character. The reason for this was that the purposes of explanation were other than those of modern science. In the integration of ideology and politics with the socioeconomic structure and the material basis of society, there was such an intimate mixture of the elements of the ideology and those of the infrastructure that it is not possible to separate them into two distinct entities. Thus, astronomical observation and calendrical science formed an important part of the ideology, which gave cohesion to that society and functioned as an instrument of power in the hands of the ruling class.

By means of astronomical observation and the application of the mathematical laws contained within the calendrical cycles, the ancient Mexicans endeavored to create an enduring system of order encompassing human society as well as the universe. In spite of the numerous transformations that doubtless took place throughout Mesoamerican history, since pre-Classic times there had been a great continuity, a kind of leitmotiv, with respect to the effort of "imposing an order on the chaos" of natural phenomena. This "chaos" was clearly evident in the geographical conditions of Mesoamerica – a region of volcanic activity, consisting of a great variety of altitudes and ecological zones. Its climatic conditions were also prone to chaos and natural disasters: with respect to the extreme temperatures between day and night and between sun and shade; with respect to torrential rains, inundations, frost and hail on the one hand and extreme heat and droughts on the other. On the social level, Mesoamerica can also be characterized by a rather varied history; since remote times, this area has experienced the interaction of numerous peoples, migrations, and constant inter-cultural contacts.

We can observe this effort to "impose order on chaos" in the following spheres of Mesoamerican culture throughout its historical evolution:

Architecture. We can detect two opposing tendencies in Mesoamerican architecture: a tendency to achieve harmony with nature within the architectural context, creating a cultural replica of the environment, and a tendency to differentiate architecture from the surroundings. The latter effect was achieved by means of straight lines, constructions of plain stone, platforms, and pyramids, which established a sharp contrast to the vegetation in the vicinity. This applies particularly to the tropical regions. The use of red color on the buildings and pyramid walls also evoked an artificial distance from the natural setting. In this way, ancient Mesoamerican architecture created an artificial order in contraposition

to nature; it imposed a new structure, a "human order," upon the "natural order".

The Calendrical System. As we have seen, the calendrical system imposed a cyclical order derived from astronomical cycles upon social life. In this sense, the calendar established a relation between the cosmos and society, binding both into one single system. In the related branch of astrology (which was exuberantly developed on the eve of the Conquest), the objective was to extend the same "predictability" of natural phenomena to social and individual life. In this field, Mesoamerican man left the terrain of scientific observation completely behind.

The Orientation of Buildings and Archaeological Sites. Calendrical sciences, astronomy, and architecture were combined into a single *cosmovisión* by means of the orientation of buildings and archaeological sites. In this way, a truly "new order" was created as a unique structure of time and space, representing a mirror of the cosmic order (as revealed by the course of the constellations). We know that other ancient civilizations also endeavored to achieve this goal; nevertheless, in Mesoamerica it seems to have reached an astonishing degree of elaboration and perfection.

Indigenous Chronology and Historiography. Indigenous historical chronology also reflects an effort to combine the calendrical record with the record of historical periods. This "cosmic history" includes the *Leyenda de los Soles*, which, I believe, reflected the historical experience of Mesoamerica.[44] The origins of ruling dynasties were also situated in such cosmic periods. The government of rulers frequently lasted 52 years, i.e., exactly one major calendrical cycle; certain events took place on specific calendrical dates that repeated themselvs periodically; the birth dates of rulers and priests were highly symbolic, as well as the dates of their deaths. The calendrical counts of different peoples and ethnic groups did not only represent a temporal-spatial order, but were, at the same time, a geographical-political ordering of society, as Paul Kirchhoff has demonstrated in several studies.[45]

Ritual. On the one hand, Aztec cult was based on the calendar, depending on its cyclical recurrence, and on the other hand, it was the concrete realization of the relation defined by myth. The rites took place in the temples and ceremonial precincts that formed the center of the settlements. Thus, they established a link between architecture, calendrics, myth, and society. Ritual being fundamentally a system of social action, it imposed a socially defined order upon society, justifying it ideologically in terms of the cosmic order.

In this context I would like to quote the words of the eminent investigator of ancient Mesoamerica, Paul Kirchhoff, which adequately summarize the considerations we have presented above. This quotation is taken from his unedited notebooks, which came to light after his death. Its style is sketchy and peculiar, but it is precisely these characteristics that give it its charm:

> Ancient Mexico is a world of order, in which everything and everybody has his proper place. Thus, ancient Mexico could not have existed without an enormous mass of people that work according to what they are told to do. Man has formed for himself a very orderly image of the world. It is a world in which man has formed a unity in everything. Everything has its perfect place, there is a formula for everything; it is also a world that terrifies us because of its universality.
>
> Religion is conceived as a whole with the universe, a fact that gives great security to man. Everything has a visible structure, everything has a center. One world is destroyed and another world returns; everything is predestined. All things have their place because thus it has been prophesized. Architecture and calendrics are structuring principles: the calendar is a two-fold structuring principle, with time and with space. These cultures do not know chaos.
>
> One discovers things that appear to be disorder according to our judgment, but afterwards one discovers a much more fantastic order, e.g., that there exist a multiplicity of parallel calendars. The orderly structure can be seen in everything. . . .[46]

COSMOVISIÓN, IDEOLOGY, AND SOCIETY

It is necessary to place the considerations I have presented in this essay within the context of social reality. The concept of ideology establishes that link between religion and society. According to this approach, religion is viewed as the main expression of ideology in ancient Mesoamerican civilization and ritual as the fundamental vehicle by which that ideology was put into practice.

We understand religion as a system of symbolic representation and of action and are interested, above all, in inquiring about the social functions of this system. The underlying assumption consists of the proposition that religious theory (myth) and practice (ritual) had an important function in legitimizing the existing sociopolitical and economic conditions. Legitimization means, in this context, a coherent formulation about the structure and articulation of the social system as well as its relation to nature. Besides furnishing this coherent conceptualization,

religious ideology also propagated a system of action that was symbolically enacted—transformed into reality—by means of rites and sacrifices. Its content was expressed by myth.

It should be further pointed out that, in addition to the synchronic-functional approach, we are interested in the historical development of the institutions studied. Supposing that religious ideology is the product of man's relations to nature and within his own society, we may assume that this ideology changed with the transformation of social relations. The fundamental step in this evolution was the rise of class society and, as a consequence, the formation of the state.[47] The hypothesis consists in proposing that, parallel to these sociopolitical processes, religion acquired a new function within class society. By means of this function the new power structures, based on new relations of production, became "mystified" in their true content.[48] It was the purpose of this mystification to make the social relations appear to be just, in terms of reciprocal relations as they had existed before in egalitarian segmental society, while, objectively, the new social system now came to be based upon the domination of one class over the rest of the population. Further, the control of religious activities became a prerogative of the priests, who were the representatives of—indeed, part of—the ruling class. That is, the ruler, the priests, and, to some extent, the ruling class as a whole, appear as the necessary intermediaries between the people on the one hand and agriculture, the cosmos, and the supernatural world on the other. The function of ideology is to legitimize these relations, which, in objective terms, result in the benefit of the ruling class. While the common people give tribute in labor and material goods to the nobles, the latter return to the common people ideological goods: just government, prosperity of society, success in warfare, fertility of the crops, and the orderly functioning of the universe.

If we analyze the place of astronomy within this context, we can realize its extraordinary ideological importance. Since astronomical and calendrical sciences were based upon the observation of natural cycles and recurrent phenomena, they provided those who had access to this knowledge with the ability to give the appearance of controlling those phenomena and producing them deliberately. At certain significant dates, the calendar required the execution of ceremonies. These could only be performed by the priest-rulers, since they possessed the monopoly of the state cult. Although intimately related to agriculture, these ceremonies took place at the great pyramids that formed the center of the urban settlements, and were, at the same time, the territorial symbol of po-

litical power. Thus, the priest-rulers created the illusion that they were indispensable to the proper execution of the rites on which depended the recurrence of natural phenomena, the growing of maize and other food-plants, and the successful accomplishment of agricultural cycles. *Cult as social action produced a transference of associations that reversed the causal relationship and made natural phenomena appear to be a consequence of the proper performance of ritual.*

To what extent did this endeavor of the priests become their own obsession, or did they deliberately use it as an instrument of domination? In fact, both factors were intimately related. The foundation of the power of these priest-rulers resided precisely in the combination of their monopoly of astronomical observation and its application to the agricultural cycles; thus, they simultaneously controlled important aspects of social, economic, and political life.

What was the nature of this ruling class? How accurate is it to speak of a theocracy? Another comment by Paul Kirchhoff, preserved in his unedited notebooks, addresses these questions. According to this scholar,

> To understand the nature of theocracy, one has to make comparisons. The only theocracies that we know of are abortive conquest states that later retired to religion. One should be very careful with the term "theocracy." Its reflection is found in religious organization. The priests form part of the state apparatus. Within this capacity, they are full-time specialists. These specialists are able to obtain a status and hierarchy in the state organization according to the influence they exercise within the state as they have produced it.[49]

What transformations did this ruling class experience from the time of its rise in pre-Classic times to the Classic and the post-Classic? It seems that, initially, the legitimization of government was made entirely in religious terms. *Cosmovisión* and astronomy were fundamental in giving cohesion to the process of the formation of the state. Was the ideology of the equilibrium of natural forces and the pretension of the priest-rulers to guarantee this equilibrium by means of their cult an adequate expression of a real equilibrium that existed during Classic times in the socio-economic and political relations between the urban centers and the rural peasant comunities? In this case, we are thinking, above all, of the great metropolis of Teotihuacan and its "empire." Was the breaking up of this equilibrium the main cause of the cataclysm of the Classic cultures?

With the rise of a military ruling class during the Post-Classic age, in

what way did the elements of this *cosmovisión* change, and were any alternatives to this explanation of the cosmos developed? With respect to this point we also ask ourselves, How far had this ideology initially been a driving force for socioeconomic and political evolution, and from which particular moment might it have converted itself into a "conservative ideology," an instrument for maintaining in power a ruling class that hindered the transformation of society beyond the material limits it had reached? Or, to put it in other terms, to what extent were the same "forms" and "structures" maintained during later periods, while their "function" changed within the ideology of that society?

These questions equally apply to the role that astronomy played within society throughout Mesoamerican history. Naturally, ethnohistorical documents only give ample testimony of conditions on the eve of the Conquest and for earlier periods we have to rely on archaeological and iconographic sources. Unfortunately, only too few pre-Hispanic codices have survived destruction by the Spaniards after the Conquest. However, the importance of astronomy has been established beyond any doubt from the interdisciplinary research undertaken in the last few years in the field of archaeoastronomy. The preceding considerations on the interrelationship between astronomy, *cosmovisión*, and society have raised more questions than can be answered at present; perhaps they can contribute to the development of further lines of research on the complex and fascinating ways in which pre-Hispanic man perceived the world and cosmos that surrounded him.

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NOTES AND REFERENCES

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2. I became interested in this subject quite some years ago when, from the point of view of my research on Aztec religion, I became aware of the need to know more about the astronomical dimensions of Aztec calendrics and cult matters. Earlier authors—Seler, Beyer, Lehmann, etc.—naturally influenced me in my interests, but I am especially indebted to K. A. Nowotny and Paul Kirchhoff, and, more recently, to A. Aveni, H. Hartung, and F. Tichy. I owe very much to Franz Tichy's studies of the orientation of Mexican pyramids, in which he combines cultural geography and astronomy with an ethnohistorical study of the Mesoamerican calendar. His recent research shares much with Kirchhoff's approach to the study of pre-Hispanic chronology, and, in a way, can be considered its fruitful continuation.

3. See Aveni,[1] *Skywatchers*; Johanna Broda, "The Mexican Calendar," *Acta Ethnologica et Linguistica*, no. 25 (Vienna: 1969); Alfonso Caso, *Los Calendarios Prehispánicos* (México: Universidad Nacional Autónoma de México, 1967).

4. See Vincent H. Malmstrom, "Origin of the Mesoamerican 260-Day Calendar," *Science*, vol. 181 (1973), pp. 939-41; Robert H. Merrill, "Maya Sun Calendar Dictum Disproved," *American Antiquity*, vol. 10 (1945), pp. 307-11; Zelia Nuttall, "La Observación del Paso del Sol por el Zenit por los Antiguos Habitantes de la América Tropical," *Publicaciones de la Secretaria de Educación Publica*, vol. 17 (Mexico: 1928), no. 20.

5. See the *Dresden Codex*; for an excellent synthesis of the interpretation of the astronomical contents of this unique pre-Hispanic codex, see Aveni,[1] *Skywatchers*, pp. 161–83.

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9. Kubler,[9] p. 116.

10. Tichy,[8] "Ordnung," p. 123.

11. In the latitude of Cholula (19° 3'), the sun reaches the altitude of 94.5° on the meridian of the southern horizon, which means that it moves 4.5° north of the altitude of the zenith. This fact is very interesting, since, according to Tichy, 4.5° was the pre-Hispanic unit used to divide the circle into 80 parts (Tichy,[8] "Ordnung," pp. 128–29). These and several other calendrical reasons suggest that the location of Cholula might have been selected on the basis of cosmological considerations. The same might apply to Malinalco and Xochicalco, which both have practically the same latitude as Cholula. It has also been suggested that the latitude of Copán, Honduras might have been deliberately selected for calendrical reasons (see Malmstrom[4]).

12. Ricketson;[5] Tichy,[8] "Ordnung," fig. 10.

13. Tichy,[8] "Ordnung," p. 118.

14. Fuson,[4] p. 499.

15. Ulrich Kohler, "On the Significance of the Aztec Day Sign 'Olin,'" in *Time and Space in Ancient Mesoamerican Cosmovision*, ed. F. Tichy and A. F. Aveni (University of Erlangen-Nurenberg: in press).

16. Rafael Girard, *Los Mayos Eternos* (Mexico: Libro Mex., 1966).

17. See Kohler;[15] Alfonso Villa Rojas, "Los Conceptos de Espacio y Tiempo Entre los Grupos Mayances Contemporáneos," in *Tiempo y Realidad en el Pensamiento Maya. Ensayo de Acercamiento*, ed. M. Leon-Portilla (Mexico: Instituto de Investigaciones Históricas, serie Culturas Mesoamericanas 2, UNAM, 1968), pp. 119–67; Evon Z. Vogt, *Zinacantan. A Maya Community in the Highlands of Chiapas* (Cambridge, Mass.: The Belknap Press of Harvard University Press, 1969).

18. See Tichy,[8] "Sonnenbeobachtungen."

19. Tichy,[8] "Sonnenbeobachtungen."

20. A population living at the northern limits of Teotihuacan civilization built a ceremonial site precisely at the Tropic of Cancer. This site, Alta Vista (Zacatecas), consisted of several constructions that specifically permitted the observation of the summer solstice, i.e., the zenith. It is impossible to overestimate the calendrical importance of this site, the location of which cannot but have been chosen deliberately. Therefore, the recent excavations and measurements undertaken by Kelley, Aveni, and Hartung at Alta Vista acquire a particular significance (Aveni *et al.*,[7] "Alta Vista").

21. See Pedro Carrasco, "Las Fiestas de los Meses Mexicanos," in *Mesoamerica: Homenaje al Doctor Paul Kirchhoff* (Mexico: SEP-INAH, 1979), pp. 51–60.

22. Tichy,[8] "Festkalender," pp. 129–34.

23. Hartung,[7] "Scheme," p. 194.

24. Aveni and Hartung,[7] Tichy,[8] "Festkalender," p. 131–32, "Sonnenbeobachtungen."

25. The aforementioned studies by Tichy and Aveni and Hartung[24] contain the first serious measurments and interpretations of the astronomical significance of the tube that have been made at Xochicalco. However, they did not take into consideration the fact that, although the center line of the tube is vertical, its northern side is slightly inclined to the south, which gives an orientation towards noon on the day of the summer solstice (private communication from Emilio Bejarano, director of the Centro Regional del INAH, Cuernavaca, Morelos, and personal observation on zenith and solstice days, May-June, 1980).

26. Tichy,[8] "Calendario," "Festkalender," "Ordnung," "Sonnenbeobachtungen."

27. The true length of the year could be observed not only by the zenith passages, but also by the recurrence of the position of certain stars and constellations. In this context, the heliacal risings were considered most important, particularly so the heliacal rising of the Pleiades (see Johanna Broda, "La Fiesta Azteca del Fuego Nuevo y el Culto de las Pléyades," in *Time and Space in Ancient Mesoamerican Cosmovision*, ed. F. Tichy and A. F. Aveni (University of Erlangen-Nurenberg: in press))

28. Tichy,[8] "Calendario," "Festkalender," "Ordnung," "Orientación," "Sonnenbeobachtungen."

29. Perhaps one should explore further the possibility that there existed different kinds of calendrical counts that functioned in a parallel way. The Vague Year of 365 days was a mathematical necessity for the calendrical system. However, an agricultural year in tune with the seasons was a practical necessity. The big question still remains, How would this "pragmatic" agricultural year have been coordinated with the rigid cycles of the calendar? A calendar correction of thirteen days every 52 years might have been a possibility; however, so far no proof for this or any other calendar correction has been found in the historical or archaeological record (see Broda).[27]

30. Edouarde De Jonghe, "Le Calendrier Mexicain," *Journal de la Société des Americanistes*, vol. 3 (1906) no. 2, pp. 197–229; Karl Anton Nowotny, "Die Aztekischen Festkreise," *Zeitschrift für Ethnologie*, vol. 93 (1968), pp. 84–106; Eduard Seler, *Gesammelte Abhandlungen*, 5 vols. (Berlin: 1902–24).

31. See Carrasco.[21]

32. See Johanna Broda, "Relaciones Politicas Ritualizadas: El Ritual como Expresión de una Ideologia," in *Economia Politica e Ideologia en el México Prehispánico*, ed. P. Carrasco and J. Broda (Nueva Imagen-CISINAH, 1978), pp. 219–55.

33. Fray Francisco de las Navas, *Calendario de Fray Francisco de las Navas, de Don Antonio de Guevara y Anónimo Tlaxcalteca*, manuscrito inédito, Colección Ramirez, Opúsculos Históricos, tomo 21, Colección Antigua, vol. 210, pp. 93–203 (Archivo Histórico del INAH, Mexico).

34. Carrasco.[21]

35. See Johanna Broda, "Tlacaxipehualiztli: A Reconstruction of an Aztec Calendar Festival from 16th Century Sources," *Revista Española de Antropología Americana*, vol. 5 (1970), pp. 197–274.

36. See Broda.[27]

37. This table is based upon astronomical data provided in Aveni,[1] chap. 3. I would also like to acknowledge Aveni's personal communications on these points. A more detailed comment on this table can be found in Broda,[27] and Johanna Broda, "Ciclos Agricolas y Culto Mexica," unpublished.

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The Role of the Pleiades and of the Southern Cross and α and β Centauri in the Calendar of the Incas," this volume.

39. GARY URTON, *At the Crossroads of the Earth and the Sky: An Andean Cosmology*. Latin American Monographs (Austin: University of Texas Press, in press).

40. AVENI,[3] *Skywatchers*, p. 296.

41. BRODA.[37]

42. BRODA.[37]

43. BRODA,[27, 32, 35, 37] JOHANNA BRODA, "Cosmovisión y Estructuras de Poder en la Evolución Cultural Mesoamericana," *Comunicaciones, Simposio de la Fundación Alemana para la Investigación Científica*, vol. 15 (1978), pp. 165–72; "Los Estamentos en el Ceremonial Mexica," in *Estratificación Social en la Mesoamérica Prehispánica*, ed. P. Carrasco, J. Broda, *et al.* (México: SEP-INAH, 1976), pp. 37–66.

44. See WALTER LEHMANN, *Die Geschichte der Königreiche von Colhuacan und Mexiko. Quellenwerke zur Alten Geschichte Amerikas*, vol. 1 (Stuttgart-Berlin: Verlag Kohlhammer, 1938).

45. Unfortunately, most of these studies are in his unedited notebooks. It is urgent that someone edit these valuable notes and papers, so that they may be available for future research. See PAUL KIRCHHOFF, *Unedited Papers*. Archivo del Museo Nacional de Antropología e Historia, Mexico; see also "Calendarios Tenochca, Tlatelolca y Otros," *Revista Mexicana de Estudios Antropológicos*, vol. 14 (1954–55); "The Mexican Calendar and the Founding of Tenochtitlan-Tlatelolco," *Transactions of the New York Academy of Sciences*, 2nd ser., vol. 12 (1950) no. 4, pp. 126–32.

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THE FIRST AGE

...UE TO TIME

... the cosmic night (Pō) of creation forms in the Kumulipo, the universe begins in motion. This motion is a movement (kāhuli) of the sky (lani) against the earth (honua). The relative movement ... rotation of the sky against the earth begins at a ... point in space (au). It begins also in time ... conceived as a flow or current (au) around the ... Thus, in one term, *au*, the concept of time ... through space as a current combines all ... concepts: time, space, and the flow (au) of ... The direction of this flow is a revolving or turning over, under and around (kāhuli) the earth in a cosmic swirl of space. The direction is discernible by observing the rotation of stellar and lunar lights piercing the vast darkness (lipo) of the night (pō) as they move in relation to the sun and to the earth from horizon to horizon. The stellar lights in the night sky are thus seen as proceeding from east ... west in regular rotation.

...o relative motions in space and time are de...ed in the opening prologue. One is the daily rotation discerned by the opposition of sunlight (lā) to moonlight (malama) or that of the day (ao) to the night (pō). The other is the movement of time through the year commencing in the season of Makali'i (ke au o Makali'i) when the Pleiades (Makali'i, Little-Eyes) first rose in the evening between the autumn equinox (September 21) and the winter solstice (December 21). The Pleiades, ...ich lie in the ecliptic, were thus the fiducial ...int for the calculation of the year (makahiki).

THE MAKAHIKI

The term *makahiki* in Hawaiian was applied both to the year of twelve months and to the four-month season of sports and tax-gathering, *makahiki*, in honor of the god of agriculture, *Lono-i-ka-makahiki*. Lono was symbolized in the voice of winter thunderstorms which boomed in the months from October-November (Ikuwā) through December-January (Makali'i) when the winter (ho'oilo) rains are in season. Since the calendars vary from island to island in Hawai'i, causing serious regional conflicts in different commentaries on the *makahiki*, it is wise to consider the *makahiki* year with reference to basic astronomical facts which the Kumulipo does not examine analytically. It elicits in words of poetry the factor of astronomical time as the theme at the core of its organizational and thematic structure. Implicit in the two relative motions of the prologue, one diurnal and the other annual, is the analogy of the ordinary night (pō), or the equivalent of one lunar phase of the month (malama), to a cosmic era of creation as a great epochal night (Pō). As one lunar night (pō) is one-half of a full day (ao), it follows that one great epochal night (Pō) is one-half of a year (makahiki) or a period of six months to be followed by the complement of the other half of the year, the epochal day (Ao), or another six months. Taken together, the epochal Pō and Ao combined should equal a full year (makahiki) or the annual rotation from one rising of the Pleiades (Makali'i) to the next rising of the same constellation.

CALCULATION OF THE HAWAIIAN CALENDAR

Around this topic, the Hawaiian calculation of time, there has been much misconception. The basis for dividing the year into twelve months by lunar reckoning was discussed by Clarice B. Taylor:

"The moon, *mahina*, was the Hawaiians' most important time-keeper because the moon not only divided the year into months, but divided the month into days. The time in which the moon traveled the skies from its rising in the west until the night of darkness set the number of days in the month. *The rising of the moon in the evening until the setting of the moon in the morning established the night.* The Hawaiian did not divide the twenty-four hour night into hours and minutes."[1]

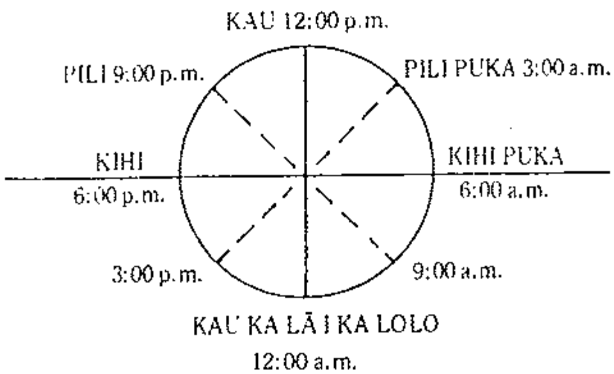
A different description of this clock has been offered by Fornander.[2]

"The Hawaiian day commenced at 12:00 midnight and ran till next midnight. There being only 12 months in the Hawaiian year of 30 days each, or in all 360 days, 5 days were added at the end of the month Welehu so that the civil or SOLAR year began on the sixth day of the month Makali'i. The feast of Lono was celebrated during the five intercalary days. For eight months of the year there were four kapu nights and days (Ku, Hua, Kaloa, and Kane) in each month. The four kapu times of the month were also called NA LA KAPU

KAUILA. The Hawaiian division of the night was:

1. Kihi — 6:00 p.m.
2. Pili — 9:00 p.m.
3. Kau — 12:00 midnight
4. Pili puka — 3:00 a.m.
5. Kihi puka — 6:00 a.m.

Missing from Fornander's list is 'noon', *kau ka lā i ka lolo,* 'The sun stands over the brain,' or *awakea* (ā, 'belonging to', or 'in the manner of', *Wakea,* 'Space, sky-father').



A close parallel to the Hawaiian night clock is found in Cambodia: "The Cambodians divide the day into two parts of twelve hours each: the part from 6 a.m. to 6 p.m. is day, and that from 6 p.m. to 6 a.m. is night . . . the night is sometimes divided into four watches of three hours each: the first from sunset to 9 p.m., the second from 9 p.m. to midnight, the third from midnight to 3 a.m., and the fourth from 3 a.m. till daytime, i.e., 6 a.m."[3]

From the midpoint of the night to the midpoint of the day, *Kau ka lā i ka lolo* (the-sun-hangs-over-the-brain), the equivalent time between two *Kihi* elapses. Since the Hawaiian day began at midnight, the "quartering" of the clock at night should have continued through the daylight. Late afternoon was called *'auinalā,* 'the declining sun'; evening *ahiahi* (< Malay *rabi* 'evening'). *Kihi* 'corner' suggests an angular shape to the clock. *Pili* means 'close to', therefore *pili aumoe* 'close to midnight' (aumoe); *pili puka* 'close to sunrise' (puka).

Logic compels one to regard the manner in which these terms are used, because they suggest that the moon was not a reference for the night divisions of the clock (per Taylor). Midnight was referable to the Milky Way or any comparable set of stars crossing the meridian at midnight, alluded to as *ua huli ka i'a,* 'the fish has turned'. It was the regularity of the *sun's* setting and rising that determined the points of *Kihi* in the evening and in the morning. The moon rises and sets at different times of the night and is not visible at all at *Muku* (cut-off), the concluding phase. It is the *sun, not the moon,* which regulates the clock. *Wana'ao* 'dawn' is named for sunlight (ao), for the streaks which like the spines of *wana* (sea urchin) radiate through the clouds at daybreak.

While the moon phases were used to determine the length of the lunar year, they were apparently not the sole means of calculation. The Hawaiian month was a fixed duration of 30 days, irrespective of the number of lunar phases by which a month would vary in length. The week was also fixed at 10 days, the ten-day week being called an *anahulu,* or a measure (ana) of 10 (hulu). There were three ten-day weeks to a month and 36 ten-day weeks to the fixed year of 360 days plus five intercalary days at the end of Welehu (December), making 365 days to the Hawaiian year. A lunar year of twelve months is 354 days, allowing 29.5 days per month and requiring an eleven-day intercalation. According to Nathaniel B. Emerson:

"The Hawaiians evidently hit upon the synodic month and made it their standard. Their close approximation to it cannot fail to inspire respect for the powers of observation and the scientific faculty of the ancient Hawaiians. It was an easy matter to eke out the reckoning by omitting the last day in every other month, the synodic month being 29½ days."[4]

Let it be supposed, however, that Fornander's account of the 365-day year ignores the likelihood of European influence after contact, is there evidence for calculation of the 365-day year before that time? The evidence from the fundamental category of the ten-day week is already proof against late introduction. The obsolete word for 'ten', *hulu,* as in the word for 'week', *anahulu,* had been replaced in general usage by *'umi* 'ten' *(kumi,* '10 fathoms'), but the Hawaiians continued to use the obsolete term *hulu* 'ten' in the word for week. Thirty-six ten-day weeks account for 360 days, so was the five-day intercalation introduced?

"The Polynesian year, as stated by Ellis, Fornander, Moerenhout, and others, was *regulated by the rising of the Pleiades, as the month of Makali'i began when that constellation rose at sunset, i.e., about November 20. The approximate length of the solar year was also well known to the Hawaiians.*"[5]

The significant use of the Pleiades as the fiducial point for the year has been observed in calendars of advanced agricultural societies:

"It is the surmise that the striking naked-eye cluster, the Pleiades, must have been one of the earliest noted star groups, and it became *the first star group for providing the fairly close determination of the length of the year approximately as 365 days* . . . the rising of this cluster in the evening was a mark of the coming winter to primitive man, and the husbandman judged the time of reaping by its rising, and of ploughing by its setting in very ancient times; Sirius, Arcturus, the Hyades and Orion were similarly equally useful to him . . ."[6]

The practice has been documented among the Santal of India: "During the night the time is indicated not only by the position of the moon but also by the stars and *particularly by reference to the Pleiades.*"[7] A similar practice occurs in Borneo:

> ". . . the length of the day varies very little in the tropics, and the native has no means of observing that variation. He is therefore obliged to have recourse to the stars or the sun to tell the time of the year . . . The Dayaks and many of the less important tribes look to the stars to guide them. Everyday, as they know, these bodies rise a little earlier and some wise man is appointed to go out before dawn *to watch for the Pleiades . . . or Apai Andau (the father of the day)* . . . Dayaks use the Malay expression . . . *Only when the Pleiades are at the zenith do they think it advisable to burn and sow* . . ."[8]

Studies of the Great Pyramid of Cheops at Giza, Egypt, suggest that the structure may have been coordinated with astronomical time in such a way as to allow prominent stars of ritual or calendrical importance, such as the Pleiades and the pole star, to be aligned with the foundation.

Astronomer Royal of Scotland C. Piazzi Smyth was able to estimate, for example, that the then pole star, alpha Draconis, was in alignment with the Descending Passage of the Great Pyramid at the meridian below the pole in 2170 B.C. when another very important group of stars would have been crossing the meridian above the pole: the Pleiades. In other words, when alpha Draconis was visible down the Descending Passage, the Pleiades would have been crossing the meridian in the vertical plane of the Grand Gallery at midnight in the season of the autumn equinox.[9]

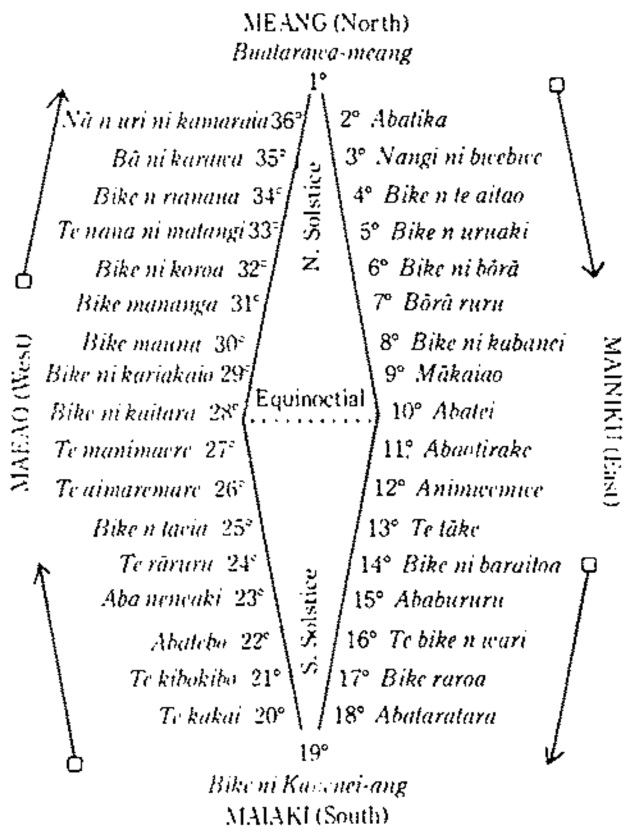
The heliacal orientation of the Pleiades to the first Babylonian decan and lunar station in the ecliptic, beginning the year at the vernal equinox about March 20–21st, means that the Pleiades would have occupied the first position in the calendar between 2000 and 1800 B.C.. About 1800 B.C. the vernal equinoctial position was vacated by the Pleiades and assumed by lambda Arietes, whereupon that point, although now actually in Pisces and soon to be in Aquarius, has since been referred to as the First Point in Aries. At the same time the Pleiades were moved to the second month after the vernal equinox, corresponding to April, or the fourth decan position (April 20th) in the Babylonian calendar.

The aberrant Moloka'i practice, therefore, of beginning the year with the Pleiades (Makali'i) about mid-April in our calendar may imply that the Moloka'i calendar at one time was oriented to heliacal risings of stars in the ecliptic. It would also mean that on Moloka'i the beginning of the year may have been oriented to the vernal, rather than the autumnal, equinox.

The nearest relative in Oceania to the Hawaiian system of reckoning by ten-day periods is the Micronesian system observed in the Gilbert Islands. The apparent movement of the sun to the northward and southward of the equator was carefully noted on Butaritari. The sun was said to pass through 36 "stations" each year. These "stations" were computed in 10-day intervals but were apparently not named for star positions:

"The northern solstice was determined by the appearance of the Pleiades, at about 5 a.m. approximately 22 degrees above the eastern horizon. This takes place, in point of fact, in the neighbourhood of the 25th of June, the true date of the solstice being 22nd June . . . While the sun was at his northern solstice, he was said to have mounted upon his Buatarawa of the north . . . From Buatarawa of the north, the sun's journey down the eastern horizon was plotted out into stages of 10 days each. On every tenth morning he was said to arrive at a new station, which was known by name to the navigator . . . From Kaitara (Autumnal Equinox) the days were counted off in nine periods of ten. On the tenth day of the last period, the sun was said to have reached his southern *loki*, or limit . . . In theory, at this point and thereafter until his arrival once more in the north, the stellar observation checking his position was now made at sunset

instead of sunrise. But in practice, the winter solstice was calculated, not by an evening consultation of the Pleiades, but simply by the count of ninety days from the time of the autumnal equinox . . . From the southern point again the sun was said to proceed, by nine stages of ten days each, up the western horizon until he again reached the Kaitara, or equinoctial . . . the western Kaitara, or vernal equinox, was also checked by a supplementary observation of the star Antares just before dawn . . . that is to say, when Antares is about 9–12 degrees past the meridian at 5 a.m. . . . and so from the Bike ni Kaitara northward up the western horizon the sun's stations were counted as before, the last period of ten-days being shortened or lengthened as the case might demand, when an observation of the Pleiades (in the morning once more), indicated that the luminary had returned to his original starting-point, the Buatarawa-meang . . . The following is a sketch of the diagram made by Biria of sticks and pebbles laid on the floor, to illustrate the principles set forth above. The sticks represent the horizon, the pebbles the ten-day stages . . . The circles after the numbers 1–36 represent the pebbles."[10]



The principle of coordinating the ecliptic into ten-day intervals between the solstices and equinoxes is a remarkable parallel between Oceanic (Hawaiian, Gilbertese) and Indo-Mediterranean (Babylonian, Egyptian) calendrical computation, as the tables on the following page will attest:

These tables show that the calendars of the Middle East and the Indo-Pacific regions had registered the shift from the Pleiades to Aries at vernal equinox circa 1800 B.C.. The position of the Pleiades (Alcyone, n-Tauri), which occupied the first Babylonian decan at the beginning of the year on March 20th about the vernal equinox, was moved to the second month of the year (April 20th), coinciding with the fourth decan of the year and lunar station Temmenu (Alcyone).

The Hawaiian calendar of Moloka'i, in which the month of Makali'i corresponds to April reflects previous knowledge of the movement of the Pleiades away from the vernal equinox by approximately 30 days, indicating a comprehension of astronomical time at a level of competence comparable to that of the astronomers of civilizations of four thousand years ago while lacking the advanced technology and mathematics of those cultures. Commentators may continue to accord the Hawaiian calendar the dubious honor of being lunar, but the Hawaiian calendar was in reality a composite calendar with three bases of coordinated calculation: the *lunar* (13 months × 28 days + 1 intercalary day = 365 days); the *solar* (36 ten-day weeks + 5 intercalary days = 365 days: the equinoxes and solstices), and the *sidereal*, computing from one vernal or autumnal equinox to another by stars or constellations. Reckoning time by the sidereal calendar would explain why the names of Hawaiian months are primarily for stars in the ecliptic, and accurate implementation of it for the purpose of navigation must forever rank as one of the Polynesians' finest intellectual achievements.

STRUCTURE OF THE WĀ CANTOS

It is important to consider the chant's sixteen subdivisions, or cantos called *wā*. The theme of time in the chant is structured upon the arrangement of these cantos as divisions of time, *wā*, meaning 'age', 'era', 'epoch', or 'period' for which the numerical components once ascribed are no longer known.

The secondary meanings of *wā* as 'shout' or 'sound' are also invoked, not merely because the *wā* were "sounded" in chanting but also because

Babylonian Decans (1800 B.C.)	36 Decans	28 Decans/Lunar Stations
Nisan (20th March) Vernal Equinox Aries	1. Dili-gana (Iku, Water Channel/ Alpha Arietes) 1. Alpha Lyrae 1. Capella/Auriga	1. Lambda Arietes, First in Aries, 1800 B.C., now in Pisces
(30th March)	2. Dili-bat (Nabat, 'She Who Proclaims')	2. Mahru-sha-rishu/Aries
(10 April)	3. Apin (Ansara), The Channel; Beta, Delta, Kappa Aquarii in lunar station Apin (Delta, Beta, Kappa Arietes)	3. Arku-sha-rishu-ku/Alpha Arietes/Hamal 'Back of the Head of Ku'
Iyyar (20th April) Taurus	1. Mula (4th Decan)	4. Temmenu/Alcyone/Pleiades in Taurus 'The Foundation Stone'; Zappu/Pleiades 'tuft of hair'
(30th April)	2. Sugi (Alpha Carinae/Argo; or Alpha + Beta Librae, The Chariot Yoke; 5th Decan)	5. Pidnu-sha-shane, Iku; Aldebaran/Hyades in Taurus; Pidnu-sha-shane, name of the zodiac; Gud-an-na/Hyades.

Lunar Stations	1	2	3	4
Sumero-Akkadian	Aquarius	Alpha Pegasi/ Markab	Beta Arietes	Pleiades + Aldebaran/ Hyades
Babylonian	Lambda Arietes (Nisan/20th March)	Aries (30th March)	Alpha Arietes (10th April)	Alcyone/Pleiades (Iyyar/30th April)
Egyptian	Beta + Lambda Gamma Arietes	Alpha Ceti/ Menkar	Pleiades	Theta Taurii/Hyades
Arabian	Beta + Gamma Arietes	Epsilon + Delta + Pi Arietes	Pleiades	Aldebaran/Hyades
Hindu	Beta + Gamma Arietes	Aries	Pleiades	Hyades
Micronesian/ Polynesian	Alpha Arietes (Ku/Lamotrek, Micronesia)	Pleiades (April, Moloka'i Hawaii/Makali'i; June, Mweriker, Micronesia)/in Taurus	Aldebaran (Un, Ul, Wuun/Lamotrek, The Penis, Micronesia)/ in Taurus	Aldebaran + Orion's Belt; Jenywen (Micronesia) Rigel in Orion; Un-Allual (Mortlocks), Aldebaran + Orion; July–August
Chinese	Alpha + Beta Arietes; 16th lunar station	Aries; 17th lunar station	Pleiades; 18th lunar station	Hyades; 19th lunar station

Data from Johnson, 1974:28; Gleadow, 1969:163; Allen, 1963:391.[11]

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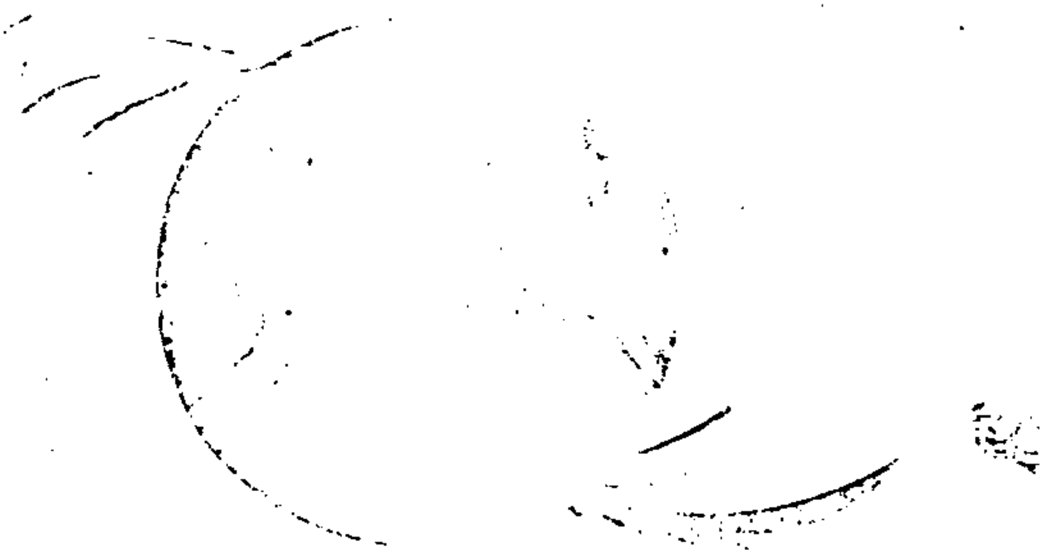

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The Spider Ecliptic in the Pacific and the Role of the Knotted Cord in its Distribution

Rubellite K. Johnson
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Background

This paper is designed as a sequel to "Implications of the Distribution of Native Names for Cotton (*Gossypium* spp.) in the Indo-Pacific," (Johnson, Rubellite K. and Bryce G. Decker, *Asian Perspectives*, Vol. 23, No. 2 (1980): 249-307).

The above-mentioned paper enlarged upon the work of S. G. Stephens ("Polynesian Cottons," *Annals of the Missouri Botanical Garden*, Vol. 50 (1963): 1-22), who broached the indigenous Polynesian knowledge of and use of *Gossypium* cottons before European contact times. He documented East and West Polynesian terms for cotton which revealed a pre-contact, ancient association in Polynesian languages with tinder, as for making fire with the fire-plow. In the Marquesas, especially, observers had noted the indigenous Marquesan tool for ginning cotton, and Stephens concluded it was unique there, that no antecedent artifact could be found for it from either east or west. The cotton tinder was also kept in a bamboo tube (pukohe). On both sides of the Pacific South America and India show the earliest dates for the use of cotton in textile manufacture:

"The Old World diploid (n=13) cultigens *G. herbaceum* and *G. arboreum* were domesticated in association with spinning and weaving in Southwest Asia (Santhanam and Hutchinson 1947:89-91), where cloth fragments were found in the remains of the Harappan civilization of the Indus Valley 2300-1700 B.C. (Vishnu-Mittre 1974). In Tehuacan

Valley, Mexico, domesticated cotton, probably G. hirsutum, has been dated to 3500-2300 B.C. (Smith and Stephens 1971:167). From Peru comes the oldest known artifact of cotton, a twined textile from the Andes dated 4550-3100 B.C. (MacNeish 1977:780), and cotton remains from coastal Peru, that have been dated about 2500 B.C., may represent an early stage in the domestication of G. barbadense (Stephens and Mosely 1974).

"The geography of ancient cotton technologies sweeps almost around the world, eastward from East Africa and the Middle East across the Pacific to the New World. The New World cottons, G. hirsutum ("upland") and G. barbadense ("Egyptian", "Sea Island") are tetraploid (n=26) and have proven vastly superior in modern cultivation to the Old World diploids, which have been displaced to relic or curiosity status by the New World cottons almost everywhere but in India, even in traditional cultivation" (Santhanam and Hutchinson 1974:97; Phillips 1976; in Johnson and Decker, 1980:249). (See map, page 4).

Since the 1980 paper, K. D. Sethna has revealed in his recent work on cotton archaeology the antiquity of Gossypium in northwest India:

"Excavations at Mehrgarh on the Bolan River in Central Baluchistan have uncovered a series of agricultural settlements more than 3000 years older than Mohenjodaro and there in Period II dating back to the fifth millenium B.C. some seeds of cotton (Gossypium) have been found. Jean Francois Jarrige and Richard H. Meadow write: 'The cotton seeds were so poorly preserved that Constantini has not yet been able to determine whether they came from a cultivated form of the plant. Their presence in association with the seeds of other cultivated plants near a structure apparently used for storage, however,

suggests that cotton was indeed cultivated by the farmers of Period II at Mehrgarh because they prized either its fiber or its oil-rich seeds'...However we can hardly postulate a parity between the cotton of Mehrgarh and that of the Harappa Culture. For the latter we have unmistakeable evidence. For the former, despite what Jarrige and Meadow urge, there is a large questionmark. The presence of the cotton-seeds in association with the seeds of other cultivated plants near a structure seeming to have been a storing-place does not automatically prove 'that cotton was indeed cultivated.'...The last word on Mehrgarh can only be in view of the charred condition in which hundreds of cotton-seeds were found in a hearth" (Sethna, K.D., Karpasa in Pre-historic India, 1981:18-26).

"Hundreds of cotton seeds...found in a hearth," should mean something, as seeds do not pile up of themselves unless someone put them there. Nevertheless, the earliest cotton textile is still from South America.

Discussion

My topic concerns the probability of diffusion in trans-Pacific culture contacts between the continents of Southeast Asia and South America. That this diffusion would penetrate through the insular Pacific creates of the island groups a maritime corridor through which some process of culture exchange must have taken place. Culture and language diffusion across the Bering Straits between northern Asia and the Americas is already well-established and may reasonably be expected, but trans-oceanic means between the hemispheres and within the tropics, except for the well-known sweet potato transfer, has been elusive.

Excerpted from Johnson, Rubellite K. and Bryce G. Decker, "Implications of the Distribution of Native Names for Cotton (<u>Gossypium</u> spp.) in the Indo-Pacific," <u>Asian</u> <u>Perspectives</u>, Vol. 23 No.2 (1980): 294.

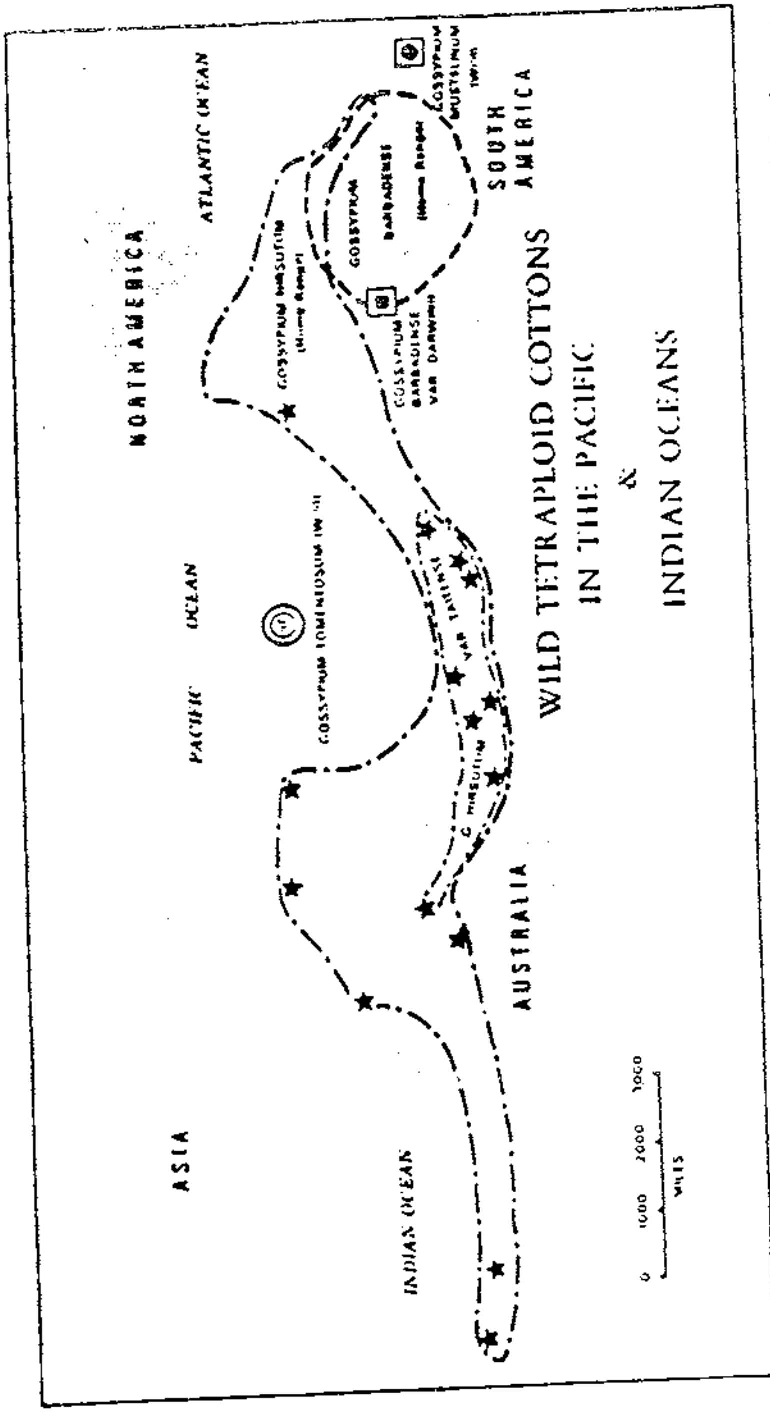


Fig. 8. Three of the four known wild tetraploid (n = 26) species of *Gossypium* have dispersed westward to Pacific Islands (Table 41), although the relative antiquity and vehicles of dispersal must remain conjectural. In Polynesia, wild cottons were gathered for minor uses as tinder and stuffing at the time of Captain James Cook's voyages (1768–1780). A probable indigenous status of the far-ranging wild varieties of *G. hirsutum* may have been obscured by free interbreeding with the domestic varieties of *G. hirsutum*, almost universally introduced in warm countries by the end of the nineteenth century.

MAP 1

I shall avoid, however, linking Polynesian culture and language origins directly with the Americas while chancing the likelihood of cultural encounter, perhaps indirectly, at some time between Polynesia and Central/South America before European contact in the 16th century A.D. With respect, especially, to the dispersal of cotton (*Gossypium* spp.) and the ethnography of cotton manufacture, there is a noticeable similarity between some cotton words found on the continental extremes of the Pacific rim. From the standpoint of fiber technology alone, and its universal antiquity in the history of mankind's experimentation with fire, and also with weaving, the "faint echoes" we hear from the sounds of such words in India and Southeast Asia reach across the Pacific Ocean from the direction of South America. Are they indigenous, independently derived within those languages, or were they taken there? Were they, in a process of culture exchange, absorbed in some brief encounter during the same time when the sweet potato came away from the Americas in Polynesian voyaging canoes?

We may consider here some of these words: Crau (Austroasiatic) *bač* ~ *pač* (*Gossypium* spp.); *paccavaṭam* (Dravidian) 'cloth' and *pañči* 'cotton cloth'; *pača* (Quechuan) 'clothes', **bač* (Proto-Mayan) 'to spin thread' (See more of this data, excerpted from the Johnson/Decker article, as appended on pages 6-7 intra.).

Given the widespread geographic dispersal of cotton (*Gossypium* spp.) between the Indian and Pacific oceans, and the evidence cited by Johnson and Decker for the ancient relationship between Indo-Iranian/Austroasiatic and Austronesian *kapās* 'cotton' (*Gossypium* spp.) and its presence in Polynesian *kafa* (Tongan) ~ *'aha* (Hawaiian) 'cord, sennit', is it sensible to lock out diffusion of terms which more than

TABLE 5. AUSTROASIATIC FORMS FOR 'COTTON' REGARDED AS LOANS FROM INDO-ARYAN

LANGUAGE	WORD
Khmer (Modern Standard)	k(r)əbah (Jacob 1974:5)
	kappāsa /kapbaah/ <Pāli kappāsa; Sanskrit karpāsa
Kuoi	kabas (Przyluski 1929)
Kanco	kopas (Cabaton 1905)
Bahnar	ko'paih (Guilleminet 1959)
Stieng	pahı (Thomas 1966)
Sedang	kopê (Cabaton 1905)
Suê	tapâ (Cabaton 1905)
Samré	kuas (Cabaton 1905)
Pear	koas (Cabaton 1905)
Crau	pać, bać (Burrow 1946:5)

TABLE 12. DRAVIDIAN FORMS FOR 'CLOTH' AND 'CLOTHING'

LANGUAGE	WORD	GLOSS
Tamil	kuppācam	'coat, bodice, jacket' (Burrow and Emeneau 1961)
Malayalam	kuppāyam	'jacket, gown, robe'
Kota	kapa:cm (kupa-ct-)	'coat, men's special dancing dress with full skirt'
Tamil	paccavaṭam	'long piece of cloth used as a blanket, bedsheet, or screen' (Burrow and Emeneau 1961:45)
Malayalam	paccavaṭam	
Kota	pacaḍ, pacaṭ	
Kannada	paccavaḍa	

TABLE 22. DRAVIDIAN WORDS FOR 'HEMP' AND 'COTTON'

LANGUAGE	WORD	GLOSS
Malayalam	paṭṭi	'hemp cloth'
	paṭṭu	
Kannada	paṭṭi	'cotton'
	paṛṭi	'cotton'
Kannada	pañji	'ball of cotton from which thread is spun'
Tamil	pañci	'cotton cloth'
	pañcu	'cotton cushion'
Malayalam	paññi	'cotton'
Toda	pōj	'cotton blossom'

TABLE 35. SOUTH AMERICAN INDIAN FORMS FOR 'CLOTH'

LANGUAGE	WORD	GLOSS	SOURCE
Xinca (from Mayan)	p'at	'cloth'	(Campbell 1972:189)
Aymara (Lake Titicaca, Bolivia)	patikala	'vari-colored textile'	(La Barre 1938:107)
(cf. Goaziro)	mawikalš	'cotton'	(Table 34)
(cf. Miskito, Nicaragua and Honduras)	sibakua kwa-la	'bark or cotton cloth wrapped around loins'	(Heath 1950:2)
Otomian (Mexico)	pahni	'shirt'	(Newman and Weitlaner 1950:18)
	pe	'to weave'	
Xinca (from Mayan)	pañuelo	'cloth'	(Campbell 1972:189)
Quechuan (Bolivia)	páča	'clothes'	(Bills, Vallejo, and Troike 1969:7)
Yana (Cuzco, Proto-Amerindian, Fox)	*bač ∼ bači p?a ∼ p?ača	'maguey-, hemp-cloth'	(Matteson et al. 1972:51, 68)
Quechuan	*bats báči		

TABLE 36. AMERICAN INDIAN PROTO-FORMS CONNECTED WITH THE SPINNING OF THREAD

LANGUAGE	WORD	GLOSS	SOURCE
Mayan-Chipaya (Bolivia)	spaht	'to spin thread'	(Olson 1965:35)
Uru-Chipaya	spahtš (s - object referent) (š - noun classifier)	'to spin thread'	(Olson 1965:35; Stark 1972:134)
Chipaya	baš?		
Chol	beč		
Yunga	paš	'to spin thread'	(Pre-Conquest Peru; Chimu culture)
Proto-Maya-Chipaya	xxpahč		
Proto-Mayan	*bač		

likely accompanied the technology involved with its uses? Isn't it sheer lack of courage to avoid the possibility, consigning every aspect of correspondence just to chance?

Let us then consider both the artifacts and the processes (i.e. verbs of weaving, tying, etc.) which surround the distribution of pyrotechnology and weaving. If the geographic distribution of these related cultural factors also demonstrates an equivalent sweep between the Indian and Pacific oceans, passing through insular Oceania also, the argument from diffusion as a factor in culture transmission between the continents of the Pacific rim through the maritime corridor of Polynesia becomes more admissible, notwithstanding the greater probability we may always assign to continual influence trickling from tribal migrations and language borrowing from north to south in the Americas.

The artifact to be considered here is the knotted cord, in Inca Peru called quipu, in Hawaii hipu'u (or līpu'u/nīpu'u), in Indonesia terbuku tali, and in India the grantha lipi. (The latter knotted cord was regarded by 19th century scholars as an embryonic system of writing practiced by adherents of the Kamphatí sect, members of which also lengthened perforated ear lobes, an item of cultural practice widely dispersed between India and the Pacific and still practiced by navigators on Puluwat atoll (Micronesia), while to the west and east the lengthened ear lobes may be seen in megalithic stone sculptures of India and Southeast Asia/Japan well into Buddhist times and most prominently in the silent heads and split ear lobes of Rapa Nui (Easter Island) stone statues).

Scholars of writing systems (Diringer, Wuttke, Lacouperie) in the 19th century regarded the Peruvian quipu as a late introduction

into South American Indian culture, despite claims to its origination there: "It was said that the later art of reckoning by quipus, notted and colored cords, was invented at Tampu-Tocco" (Mythology of All Races, Vol. 11:217).

Given the widespread distribution and antiquity of the knotted cord in Asia and the established chronicling of its uses in the earliest Chinese written records, Lacouperie, a late 19th century scholar, grouped the existing traditions of the knotted cord, including the Peruvian quipu and Hawaiian/Marquesan samples, into one cultural continuum across the Pacific from northern Asia to the Americas. To quote him:

"Polynesia was the way through which apparently the custom of knotted cord records reached the new world. The remarkable instance of dissemination we have to quote further on about the Easter Island inscriptions is highly suggestive of such a fact. It is by the Peruvians that the cord system of mnemonics was carried to the greatest perfection and the name of quippus they gave to them might be taken as a generic appellative for the system" (Lacouperie, Beginnings of Writing, 1894:14-15).

He also cited the Hawaiian hipu'u knotted cord as evidence for this inference, notwithstanding antecedent examples in Indonesia and Asia, quoting the description of the same by Tyerman and Bennet:

"The tax-gatherers, though they can neither read nor write, keep very exact accounts of all the articles, of all kinds, collected from the inhabitants through the island. This is done principally by one man, and the register is nothing more than a line of cordage from four to five hundred fathoms in length. Distinct portions of this are allot to the various districts, which are known one from another by knots,

loops, and tufts, of different shapes, sizes, and colors. Each taxpayer in the district has his part in this string, and the number of dollars, hogs, pieces of sandalwood, quantity of taro, etc. at which he is rated, is well-defined by means of marks, of the above kinds, most ingeniously diversified. It is probable that the famous quippos, a system of knots, whereby the records of the ancient Peruvian empire are said to have been kept, were a similar, and perhaps not much more comprehensive mode of reckoning dates and associating names with historical events" (Tyerman, Daniel and George Bennet, Voyages and Travels Round the World... Between the Years 1821 and 1829, London: 119). We note, by the addition of "dollars" and "sandalwood" that the Hawaiian hipu'u knotted cord was still being used in post-contact, post-missionary times).

(Persons desiring more information about the decoding of the Inca quipu should consult Marcia and Robert Ascher's work, Code of the Quipu, A Study in Media, Mathematics, and Culture, University of Michigan Press, 1981).

Lacouperie's inference that the knotted cord system in Inca culture came from Asia through Polynesia was based on a common observance that the earlier native American string devices from North to South America, as embryonic writing/message systems, were tally cords strung or netted together with pebbles and maize beans for counters, per Wuttke: "Before the time of their acquaintance with the Quippus, the Peruvians used in the same pebbles or maize-beans of various colours" (Wuttke, H. Die Entstehung der Schrift, in Lacouperie, 1894:11). Contemporary scholars (archaeoastronomers, mathematicians)

indicate that decoding of the Inca quipu is confined to samples post 1400 A.D; Pre-Columbian samples have not yet been decoded.

"Quipus remain undeciphered as to content, but their structure, their grammar, and their mathematical syntax can be clearly appreciated ...Quipu, which is the Quechua word for knot, is the term that the Incas used for their knotted string mnemonic devices. Several early references...suggest their broad use as data retrieval systems: for recording history, for census information, for treasury data, and for law court records. Also, 16th century drawings of quipus exist that by visual association, at least, link astronomy and quipus" (Conklin, William J.,"The Information System of Middle Horizon Quipus," Institute of Andean Studies, Berkeley, California, in Ethnoastronomy and Archaeoastronomy in the American Tropics, New York Academy of Science Annals, Vol. 385 (1982): 261-262).

*(Note: The above passage is illustrated by Figure 1, drawing and text by Waman Puma, dating from about 1600 A.D., with translation by Conklin, showing an astrologer-poet carrying a quipu in his left hand and a forked staff in his right hand):

> "And our Astrologer/Poet!
> Who knows of the rotation of the sun,
> And the eclipse of the moon,
> Of the stars and comets,
> Of the hours, the Sundays, the months, and years
> And of the four winds of the world
> And of the planting time for seeds for the food,
> Since time immemorial..."

At last, we have arrived at a place where the content, in this instance from Peru, of the knotted cord (including a forked staff) concerns the reckoning of time. Lacouperie's history of the cord in Asia and Indonesia mentions measuring of time by passage of the observed celestial bodies, as typical of Formosans (Western Pacific) and the Sonthals of India (Indian Ocean):

"A recent account of Formosa states that the aborigines ignore writing. 'They have not even any means of keeping time, and when they have made an appointment for any date, their only means of keeping a check on the days as they pass is by means of a tally of stones or grass, one stone or one knot in the grass representing a day"...

"Such is also the case with the Sonthals of Bengal. 'Their accounts are either notches on a stick, like those formerly used by the rustics for keeping score at cricket matches in country villages in England, or knots on a piece of grass string, or a number of bits of straw tied together...I will remember my astonishment while trying my first case between a grasping Mahajun and a Sonthal, when I ordered them to produce their accounts...the Sonthal produced from his back hair where it had been kept, I suppose, for ornament, a dirty bit of knotted grass string, and threw it on the table, requesting the court to count that, as it had got too long for him. Each knot represented a rupee, a longer space between two knots represented the lapse of a year" (Lacouperie, 1894:10, 14 from E. J. Man, Sonthalia and the Sonthals, 1867, Calcutta).

The knotted cord as a time piece, or tally of time, is also documented from the Pacific:

"D'Urville spoke of natives in the vicinity of New Ireland as being voyagers to some extent. They made voyages of 10 to 12 days to some land inhabited by people of a much lighter colour than themselves, and there obtained garments covered with designs...On one of these occasions they brought back one of these light-skinned folk, a woman, who tallied her days of absence from home by tying knots in some fabric that she wore round her neck. We know that the natives

of the Caroline, Pelew, and Hawaiian groups formerly employed the quipu, or knotted cords as mnemonic aids to memory, and that the same aid was in use among POlynesians generally" (Best, Elsdon, Polynesian Voyages, 1954:60).

The observation, then, among prominent scholars of language and culture of the 19th century (Lacouperie, etc.) claims an antiquity of wide-spread knotted cord notation, as of reckoning and timing quantification through a system of early measuring by knots and stringed objects that is impressive for its broad range of distribution: from Northern Asia across the Americas (Tibet, north of Tibet among the Yang Tung, south of Khoten; Siberia, among the Bratyki and Buriat; into Peru (Inca), where Lacouperie insists on Polynesian cultural influence; Southern Asia (India); China* and Japan; the offshore islands Hainan (Li people) and Formosa; eastward into the Ryukyu Islands, a northern Pacific route, then southward into Timor (according to Chinese records of this area, circa 1618 A.D.), penetrating eastward, perhaps earlier, through Polynesia, of which the Hawaiian knotted cord hipu'u affords the most comparable artifact to match the coloured Peruvian quipu by description if not by surviving example, as of the Marquesan knotted cord.

It is in the heart of Indonesia, however, where the tally strings and notched stick devices (which replaced the tally strings) reach an interesting level of time-keeping, indicating a more scientific approach than mere tallying of days (arithmetical notation as cumulative reckoning):

"The Kenyah (Borneo) sun dial (tukar do) measures the noon-day shadow by means of a measuring stick (asu do)...the stick lies along

*(Note: See Addendum, page 62 intra).

the extended arm, the notches corresponding to certain regions of the arm and hand...some of these spaces correspond to positions along the arm where strings have been tied*, indicating when, according to shadow lengths, it is time for planting" ("Addendum to Mr. Hose's Paper On Methods of Reckoning Time," in Royal Asiatic Society No. 42 (1904): 201-210. *(This is a combination of the notched stick and string as a further development of a rule of measure into gnomonic strategies for shadow-length measuring, employing observation of and knowledge of the sun's apparent course during the year, i.e., the ecliptic).

"The Kenyahs and Kayans judge the seasons by the sun, and the method they adopt displays a wonderful knowledge of the precautions to accuracy. The Kenyahs measure the shadow cast at midday with an instrument the Greeks would have called a gnomon. It is a pole set up near the village, guarded by a fence to keep away mischievous children and animals. In height it is more than a fathom by the span of the thumb and first finger. A piece of string weighted at each end and thrown over the top shows when it is perfectly upright.* The length of the shadow is measured by a stick called 'asu do' which is marked with notches gradually approaching one another more closely as they get further from the pole." *(Note: i.e., a plumb bob, to find level).

"The interval between successive notches represents the change in the length of the shadow in three days. Midday is known to be the time when the shadow cast by the sun is at its shortest, and the Kenyahs are also aware of the fact that the direction of the shadow at noon, though sometimes to the north and sometimes to the south, is always in the same straight line. The Kayan method, which differs

more in practice than in theory from the Kenyah, is to let in a beam of light through a hole in the roof and measure the distance from the point immediately beneath the hole to the place where the light reaches the floor. Their measure is a plank, made level so that round discs do not roll on it, and fixed in position by chocks placed at the side. This shows that they know the sun to be always due north or due south at noon."

"The best time for planting has not arrived until the noonday shadow is the length of the forearm from the tip of the fingers to the inside of the elbow.* When the shadow is less than the length of the hand, sowing is not likely to prove very productive...otherwise the Kenyahs care nothing about the heavenly bodies" (Dr. Hose, "Computing Time in Borneo," Journal Straits Branch, Royal Asiatic Society, No. 42 (1904): 4-5. *(Note: this is the cubit length, from middle finger of the extended arm to the elbow, roughly half a yard).

This represents a point of departure for the use of cordage as a stretching cord to find level, i.e., the plumb line, rather than the knotted cord, but obviously a related device for telling time, not by arithmetical notation but by calculation of the rotation of the sun (i.e., diurnal observation) versus revolution of the sun's annual passage (i.e., the ecliptic), by shadow marks.* *(i.e., the analemma).

The stretching cord is also well-documented for Hawaii as the ʻahakū or ʻaha hele honua connected with ritual ceremonies for squaring corners of sacred houses on the heiau temple ground, and therefore for finding level and center (piko, 'navel', as of ka

piko o ka honua, 'navel of the earth', meaning also 'placenta' (honua), i.e., place of maternal connection, birth; therefore, the local meridian, latitude). This 'aha hele honua is a lashing, as well, used on the voyaging canoe, as for tying the canoe float, or ama, to the iako connectives that are in turn lashed to the hull (wa'a, body). The fore and aft parts of the ama were termed kapua'i meaning 'foot', as of the measuring foot, so that crossing the equator (ka piko o ka honua, terrestrial equator) was in Hawaiian called a "trampling" (ke'ehi) over the "diaphragm (houpo) of Kāne" (i.e., the equator).

With respect, then, to this "stretching" Polynesian cord, the 'aha hele honua, as used for house, temple, and canoe construction measuring, the tradition of measuring cords acquires an additional dimension commensurate with the engineering/carpentry trade of finding straight lines of alignment and support between the structural elements of building, adding also tension and flexibility of lashing cords to wood en masse (volume and stress factors), and obtaining level and center at the base of any structure. Squaring of house corners to right angles by use of the 'ahakū and 'aha hele honua attests to Polynesian expertise in making the sides of a building equal and parallel rather than to the measuring of time, using the same tool. We may find the practice of these arts comparable to the craft, then, of the Greek arpedonapt:

"I have listened to many men," said the Greek philospher Demokritos, "but no one has yet surpassed me in the construction of figures out of lines accompanied by demonstration, not even the Egyptian arpedonapts, as they call them. Now the word αρπεδοναπτης is not Eqyptian but Greek. It means 'cord-fastener,'; and it is a striking coincidence that the oldest Indian geometrical treatise is called

the Sulvasutras or 'rules of the cord.' These things point to the use of the triangle of which the sides are as 3, 4, 5, and which has always a right angle. We know that this was used from an early date" (Burnet, John, Early Greek Philosophy, 1958:20)..."the so-called Pythagorean triangle is the application...the very name 'hypotenuse' (ὑποτείνουσα) affords strong confirmation of the intimate connection...it means literally 'the cord stretching over against,' and this is surely just the rope of the 'arpedonapt' (Ibid.:104).

The ceremony of the "stretching of the cord" in Hawaiian temple rituals provided for the high chief and the high priest to enter at night before the central sacred house, the hale wai'ea, the dimensions of which were a cubit deep, a cubit wide, by two cubits long (i.e. 18 inches by 18 inches by 36 inches , the Hawaiian cubit, ha'ilima (elbow extended to middle finger, i.e., the forearm measure, equal to half-a-yard, about 18 inches) and there to stretch the 'ahakū or 'aha hele honua. If this 'aha were not found, then the temple tabu could not be relaxed (ho'omahanahana) and could remain in effect for a long time (Malo, DAvid, Hawaiian Antiquities, 1951:161-162: I'i, John Papa, Fragments of Hawaiian History, 1983: 34-35):

"In the narrow passage back of the drumhouse (hale pahu) and at the end (kala) of the house called mana* was a small house called waiea, where the aha cord was stretched...The fourth house, called the Hale Waiea, was a small one between the Hale Umu and the Hale Pahu. It was twice the length of the distance from fingertip to elbow in length, its height and breadth being half that measure. Two

images stood before it on either side of the opening, and the king and kahuna conducted their 'aha services at the right side of the opening, in the dark the night before the birds began to twitter."

We are left so little by native Hawaiian scholars about the particulars of these ceremonies, although prayers uttered in these building ceremonies for temples of human sacrifice (i.e., Kū war heiau, po'okanaka luakini types) contain repeated references to the cord ('aha) and the sky, suggesting an adjustment between the allocation of sacred space limits to the sacred houses of the heiau, perhaps coordinated with time (sidereal, solar, lunar):

<u>Pule Ho'owilimo'o</u>
(Prayer to "twist" the lizard)

Hauli lani ka aha ka apipi
o Kane
O Kane ulu lani, hakoikoi
ka lani,
Lani ku, ka alana o aha
ula hoowilimoo
Moo lani, moo lani aukuku
ka honua
Ua wela ka hoku Kaelo
ia Makalii,
Ka auhuhu paina
O hoowilimoo ka aha nani
Nani Kukulu o Kahiki*
Ua nani ka aha,
Ua moe kaoo ka leo kanaka
E kai ka aha no ke alii

He aha noa, he aha lele

He aha kapu, he aha ku
Kulia ka aha no ke alii.
A make ka hoa paio.
Kulia ka aha no ke alii
A lu, a ola, ola ka aina
Ia oe Kane, ke akua ola!
E ola iau, ia (Mahoe) ke alii!
Ua noa! Ua kai ka aha!

From heaven fell the <u>aha</u> to the spot
favored by Kane,
Kane who arched the heavens, mottled
with clouds the whole heavens,
Gift of the sacred red <u>aha</u> of <u>hoowilimoo</u>
of the upper heavens,
Heavenly portent! heavenly portent!
that fills the earth with blessings.
The star, Kaelo, blazes in the season of
Makalii,
The bitter auhuhu scorched to brittleness,
Hoowilimoo is the beautiful service*
Beautiful is Tahiti,
Favorable are the omens for the service.
The voice of the multitude is at rest.
Now must we perform the service for the
king,
An acceptable service, one that reaches
its end,
A sacred service that shall not fail.
The assembly stands before the king.
His enemies shall melt away before him.

Pour abundance, life, life to the land
Through you, Kane, the god of life!
Life to me, to (Mahoe) the king!
It is accepted! The service is
accomplished!

*(Note: '<u>aha nani</u>, 'beautiful service'; '<u>aha</u> means the service and the cord; <u>Kukulu o Kahiki</u>, 'Pillars of Tahiti', i.e., cardinal directions, pillars of the celestial house).

Pule o Kai-a-pokea*

O Ku of the ocean at Tahiti
The sacred ocean,
Sea of the bleached skull* (* a skull filled with seawater)

Take of the sea foam
That is the brine wherewithal to consecrate
Consecrate the ohia, ohia of Kuamu, of the woodland deities, Kua-
wao, Kuawa, and Kualana
That the kaei god may make his circuit
About the pavement guarded by the aha'ula* (*red-cord)
obedient only to royalty

*(Note b: The kind of aha here meant is the cord braided of much art, of many colored strands--one of them red, ula--which was stretched as a mystic protection about the residence of an alii with a kapu...)

(Malo, 1951:181) Pule kuwa (For the linalina, decorative net-like arrangement of cords hung over the ridgepole)

O Ku in the heavens,
Behold the cord done into the all-including knot (aha o makuu-halala)
O Ku of the mystic, wonderful ridgepole (kaupaku) of Hanalei,
Bind, tie with the knotted oloa
It is the oloa that shall overturn the power
Power is wrapped up in the oloa cord
Let power go forth to the god image
Cut now the navel cord of the house mana
Virtue, virtue resides in the knotted oloa cord
That decorates the house of god Kane.
Cut now the navel string!
Done! It is done!

(Malo, 1951:184) Kau na auau (thatching)

Above the level of the ground floats the thatch pole,
Lash with a tight loop the uki leaf to this thatch pole!
Bind and lash the cord firmly
To the back of the rafters of Lono's house!
O Lono, here is a house for you, the house Mauliola!
...A sacred temple...

(Malo, 1951:183) Pule hulahula (dancing)

Resplendent the heavens, crystalline the earth, mirror-like
earth's plane,
The Milky Way inclines to the west, refulgent are the heavens.
The heavens are guarded by the Milky Way...

(Malo, 1951:183)

The Process of Tying and Knotting

Are knotted cords on either side of the Pacific rim isolated, unrelated artifacts, or is 19th century scholar Terrien Lacouperie vindicated in inferring that these artifacts are from a related process, or from a number of related processes, given the multiple uses of cords with or without knots in various kinds of measuring?

As a particular artifact by itself, the knotted cord in Hawaii and the other in Peru seem related in function and in form, but it would be difficult to relate the two in their number operations. Assuming that Quechuan numbers are in no way related to Hawaiian numbers, we would have to say Terrien Lacouperie could seize upon the like function and appearance, but that would on closer examination snag on the problem of unrelated languages. Only in one instance is there comparability and that is in the existence of a decimal system in the calculations of both Quechuan and Hawaiian numbers, that is, in the use of a base ten as common element:

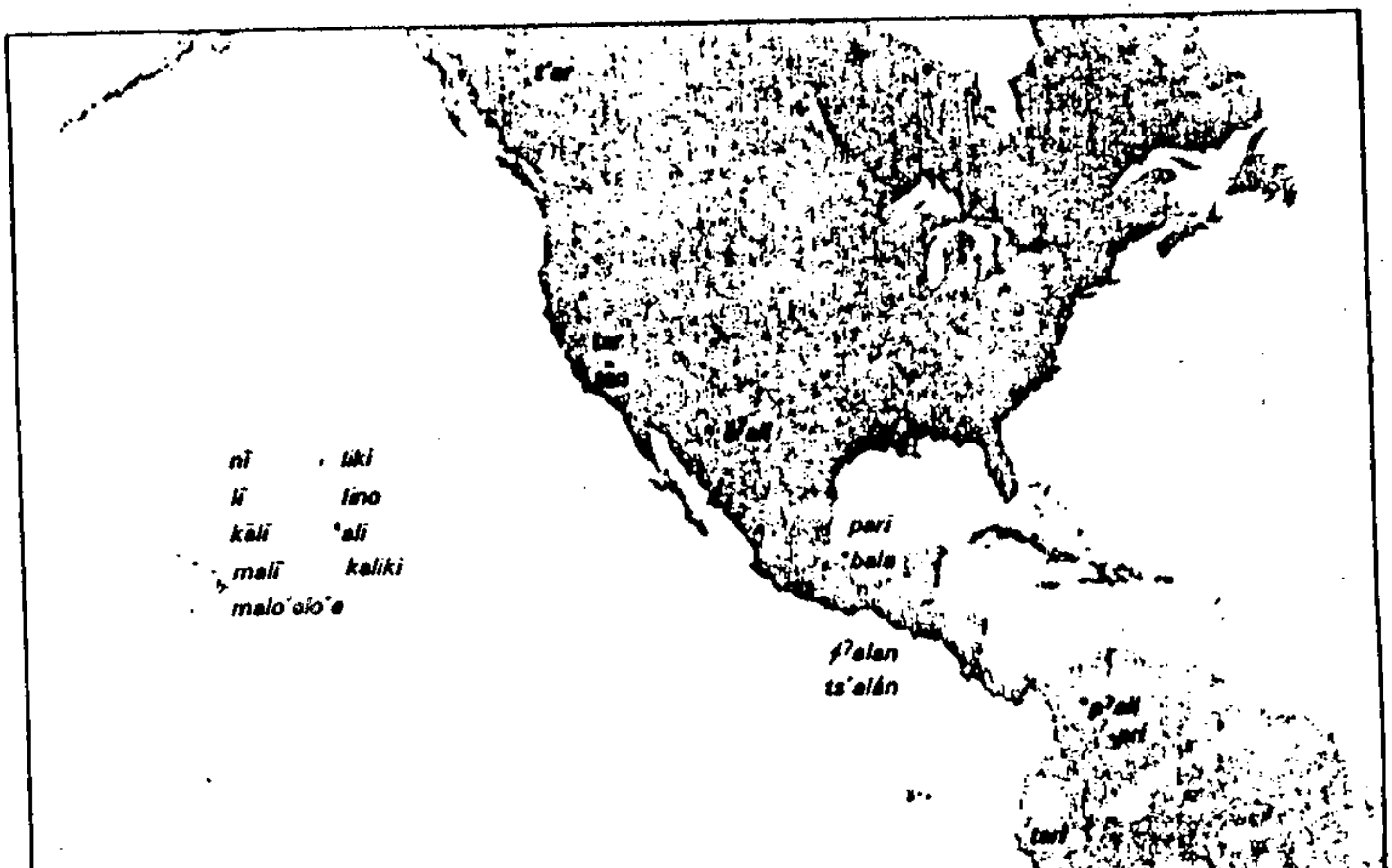
"The single most important breakthrough in understanding quipus remains that of Leland Locke, who, in 1912, demonstrated that the quipus he studied were evidently not language, but rather purely numerical in nature. He also discovered that they used a decimal counting system of a positional nature, and that the concept of zero was present" (Conklin, William, "The Information System of Middle Horizon Quipus," Annals of the New York Academy of Sciences, Vol. 385 (1982):263). (The Hawaiian system of decimal counting used place value, with assumption of the zero position in decimal multiples, increasing by multiples of four).

For other support we must then go to the verbs associated with

the tying of knots, and assuming that the tying of knots applies to other kinds of artifacts and tools, we should examine in the related context of fiber technology, words for hand-tied or hand-woven textiles, basketry, and netted fabrics (i.e., fishnets, mesh-making). It is in the process of tying, not in the number words, that the same distribution pattern emerges that was seen for the extent of cotton (<u>Gossypium</u> spp.) in the Indo-Pacific. Let us consider the most widely-distributed form as it appears over this same area. To facilitate your view of this distribution, five word distribution maps on subsequent pages are included to simplify comprehension. (See maps on pages 20-24).

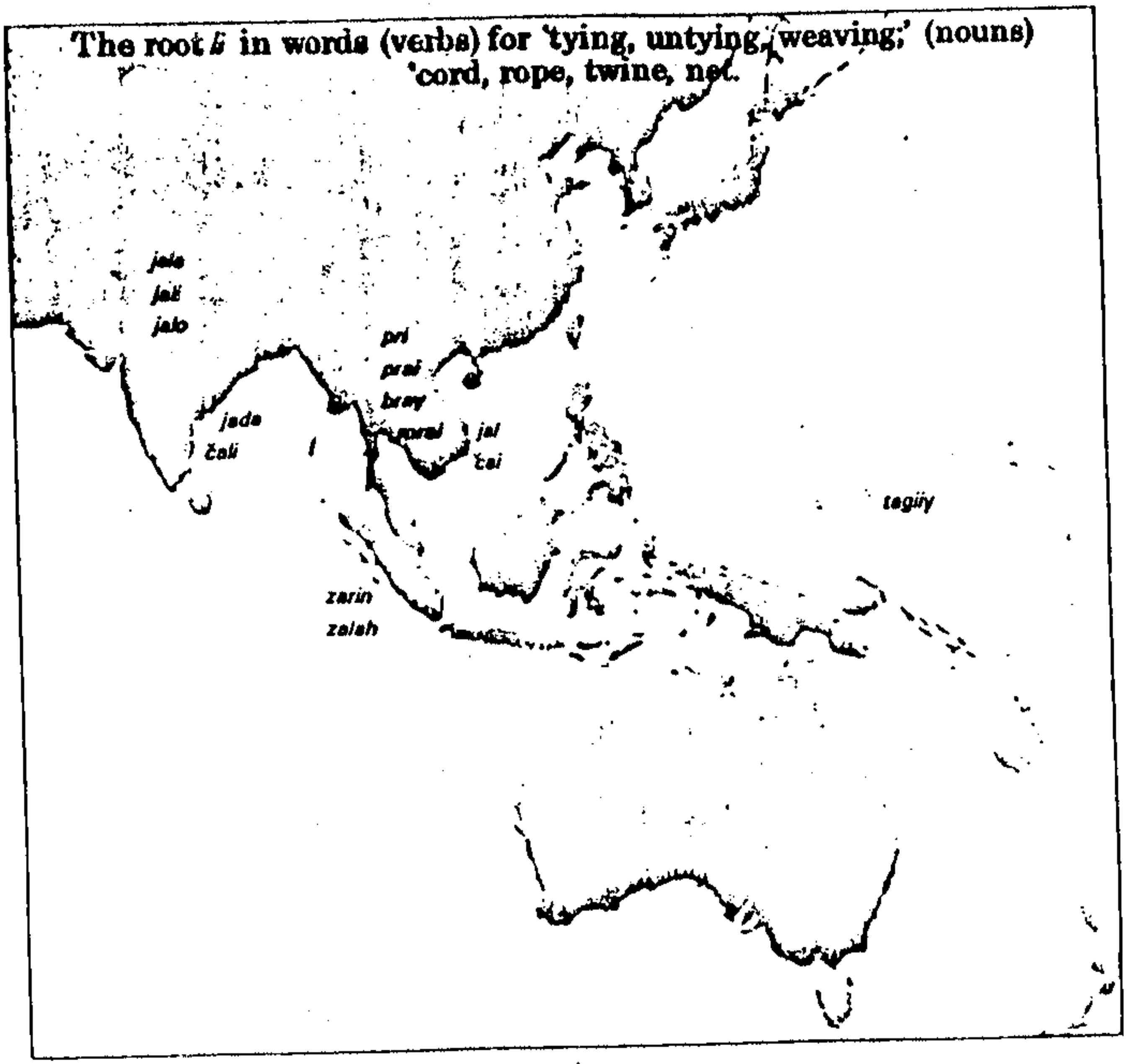
Central/South America:

Proto-Amerindian (Matteson,et.al.,1972:77)	*pʔali -pri *pʔal	'rope' 'to roll, as rope'
Mayan/Chipaya (Bolivia)	pari	'string, not well twisted'
Mayan (Olson, 1965:35)		
Proto-Mayan	*bal	'string'
Chipaya	bal(a)	'to make rope, to twist cord'
Maya/Yunga/Chipayan (Stark, 1972:134,124)		
Yunga	pal	'twisted string'
Uru-Chipaya	pazi	(to spin thread)
*Proto-Mayan	*b'əl	
(Note: Yunga, of pre-conquest Peru; language of Chimu culture, conquered by Inca; North Peru)		
Chipaya	bal	'to roll up something'
Proto-Aztecan (Lyle, 1978:262-279)	*puuli	'to tie'

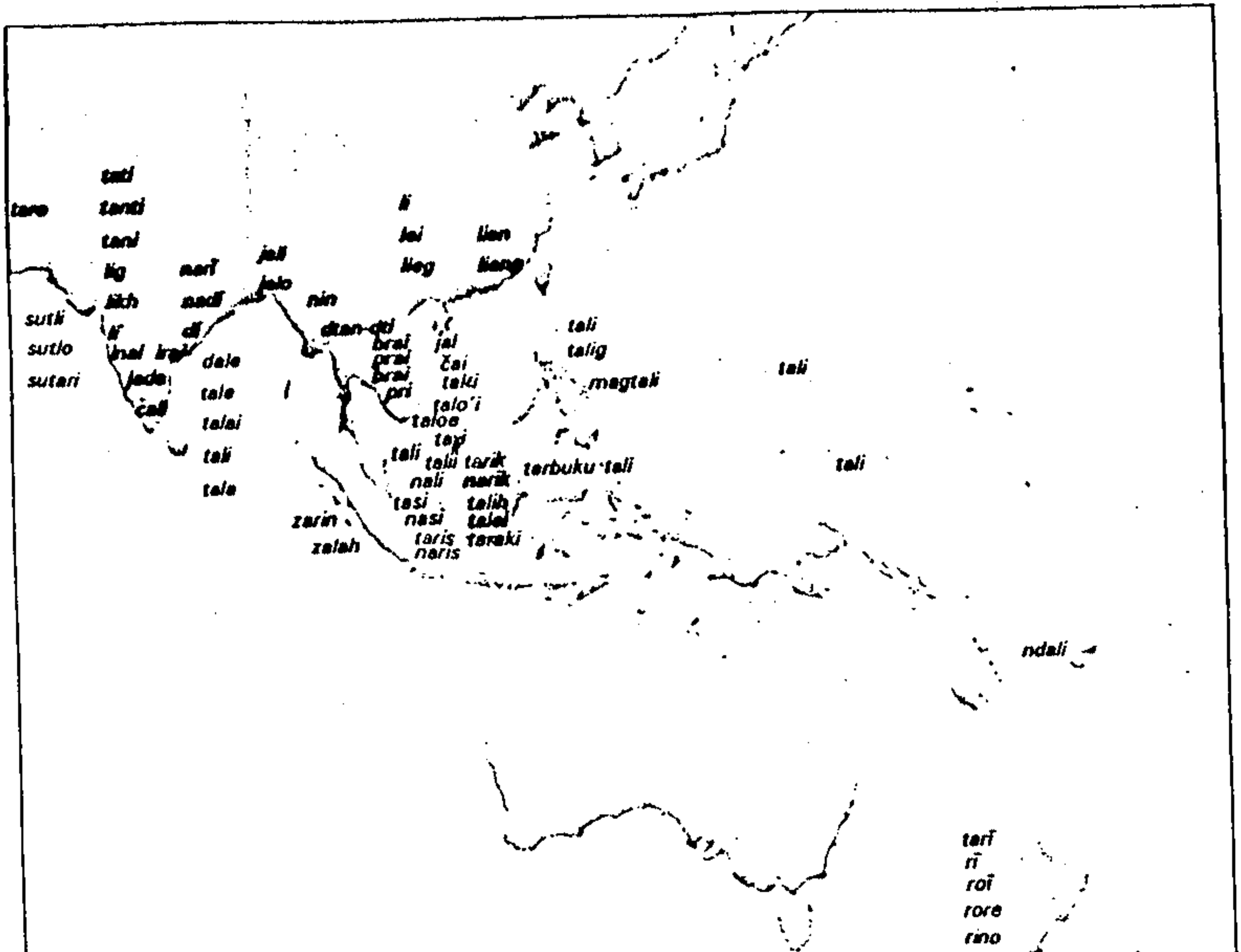


The root *li* in words (verbs) for 'tying, untying, weaving'; (nouns) 'cord, rope, twine, net'.

MAP 2

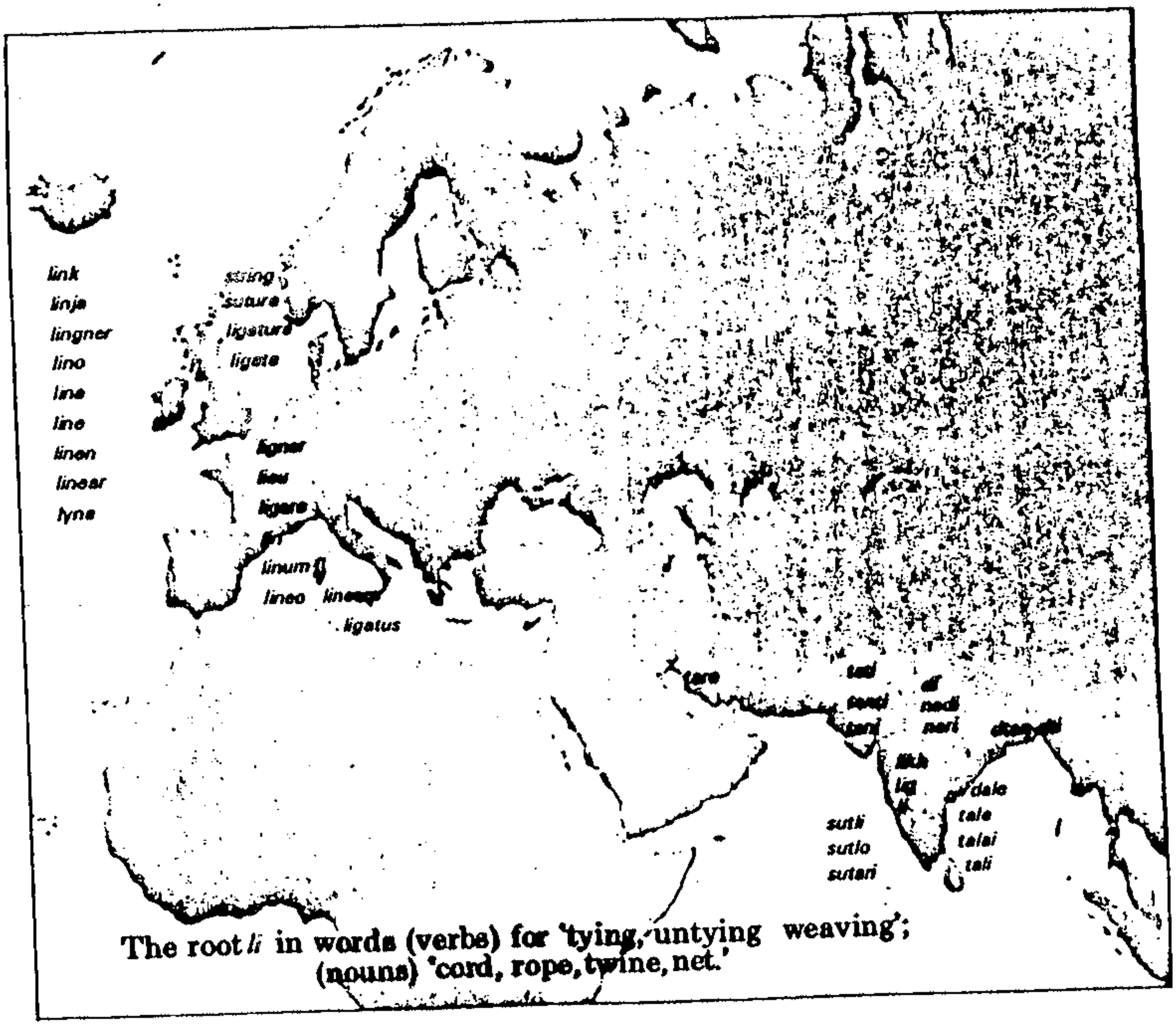

The root *li* in words (verbs) for 'tying, untying, weaving;' (nouns) 'cord, rope, twine, net.'
jale
jali
jalo
pri
prai
bray
jal
čai
jada
čali
zarin
zalah
tagiiy

MAP 3



The root *li* in words (verbs) for 'tying, untying, weaving'; (nouns) 'cord. rope, twine, net'.

MAP 4



The root *li* in words (verbs) for 'tying, untying weaving'; (nouns) 'cord, rope, twine, net.'

MAP 5

Southeast Asia (Austroasiatic/Austronesian)

Proto-Chamic (Headley, 1976:463)	mrai	'thread; silk'
Chamic	phray	
	prɛ	
Proto Central North Bahnaric	*bray	'thread'
Proto Jeh-Halang	bray	"
Mnong	brai	'bandage'
Brou	prai	
Pacoh	par<u>a</u>i	
Palaung	pɛre	
Serting	bri	
Austro-Thai (Benedict, 1975:257)	*(m)p(r,l)ali(s) (reconstructed form)	'cord, string, rope'

The distribution of the foregoing forms, with bilabial voiced /b-/ and voiceless /p-/ initial stops (+ /-ri/, /- ali/, /-ala/ (Central/South America) 'rope, string, to make/twist cord, to spin thread, to roll up (as cord)' in Proto-Amerindian, Proto-Mayan, Yunga and bilabial voiced /b-/ and voiceless /p-/ or nasal /m-/ (+ /-ri/, /-rai/ or /-ali/ (Southeast Asia) in Austroasiatic and Austronesian (Proto-Chamic/Austro-Thai) is interesting since they straddle the extremes of the Pacific rim, but they do not exist alone for the technology of weaving/cordage. Another related set of forms prefixed by initial voiced /j-/ and voiceless /č-/ affricates before the stems /-ʔali/, /-al/, /-alah/, /-alin/ (India, Southeast Asia, Indonesia) further reflected as /t-/ plus /-ārī/, /-ali/, /-ani/ reappear in the Americas north as <u>čʔali</u> (Zuni, Penutian) 'to stretch' (as cord, weaving) and <u>tsʔalán</u> (Mayan, of southeast Chiapas, Mexico) 'tied' (in which the affricate has been glottalized). Consider the sets:

Amerindian		
Tojo Labal (Mayan) (Southeastern Chiapas, Mexico) (Supple:68-174)	tsʔalán ʔalán	'tied'
Zuni, Penutian (California) (Newman, 1964:10)	čʔali	'to stretch'
Aymara (Bolivia) (La Barre:87, 117)	tari	'small cloth, shawl'
	ɬ'ahli	'measurement, four fingers wide; width of hand'
Muskhogean (Natchez in Mississippi, Louisiana) (Swanton:66)	tâl	'to weave'
Shuswap (Salish) (Thompson , 1974:23)	tál	'stretch, extend'
Coeur d'Alene (Reichard, 10:95) (Reichard, 11:55)	tʔr	'to stretch out, extend, as hand'
	tän	'be taut'
	tän	'arrayed in a line'
	tänu	'be tight'
	tânut	'clothes fit tight'
Paco-Tacanan (Macro-Quechua) (Suarez, 1973:153)	tani tan	'to tie'
(Proto-Salish) (Thompson, 1974:22-28)		
Columbian, Colville	tạ́r	'untie, loosen'
Coeur d'Alene	tár	'untie, loosen
Kalispil	taál	" "
Chipewyan (Alberta, Canada) (Li:131)	tár ʔar	'to untie a knot'
Austronesian		
Marshallese (Abo et.al,1976:84)	jālin̄lin̄	'string'
	jaljal	'loosen, unwind'
		'unsnarl, take apart'
	jāli	'kind of basket'

Austronesian		
Indonesian (Dempwolff)	zalah /djala/	'fish net'
	zarin	'hunting net'
(Borneo) Lawangan, Dusun, Tamuan	jala	'fishnet'
Chamic (Southeast Asia, continent) (Headley:465)	jāl	'net'
	čiel (from jāla)	
Malay	jala	'net'
Austroasiatic		
Sedang (Headley:465)	čéa	'net'
Bahnar	jal	'net'
Jeh	jar	"
Halang	jal	"
Stieng, Koho	j:al	"
Vietnamese	chài	"
Bonda (Assam)	jali	"

*(Note: Headley placed this in "Words of Probable Indo-European Origin";~Sanskrit jala 'net': "It is difficult to determine the direction of borrowing in this set. Kuiper (1948:62-64) suggests that it was borrowed from a Proto-Munda root dada 'matted, entangled'. Its occurrence in Vietnamese would appear to indicate great antiquity within Mon-Khmer)

Dravidian (India)		
Tamil (Burrow/Emeneau)	čentiravar (čāliyan)	'weavers'
Kannada	jāḍa, jēḍa	'a weaver beglong to the Lingavanta sect'
Telugu	jēṇḍra, dēṇḍra	'a caste of weavers'
Tulu	jade, jadye	'weaver, spider'
	čali	'sieve'

Indo-Aryan/Indo-European

Nepali (Turner)	jal	'snare'
Marathi	jale	'net'
Orissa	jala	'net'
Nepali	jali	'network'
Nepali (Turner)	tāri (f)	'to tie' (derived from Persian tār)
	tare	'having a string, wire, band'
	tare	'to tie'
Persian (Arabic)	tare angkabut	'spider's web'
	angkabut	'spider'
Nepali	tan	'warp, loom'
	tani	'stretching'
	tannu	'to pull, tighten'
	tana	'stretching'
Sanskrit (Monier-Williams)	tan	'to spin out, to weave'
	tan	'cord, string'
	tanaka	'cord' (from tan 'to stretch')
	tanika	
	tan	'to stretch'
	tantra	'web'
	tanti	'cord, string' (from tan 'cord, string'
	tantu	
Pāli (Turner)	tanti (f.)	'cord, string'
	tantu (m.)	'cord, thread'
Sanskrit	tanī	'a string with which garments are tied'
	tālī	'string, a kind of ear ornament' (from li 'to join, unite', loanword from Pali, lpi, lyi: lpinati, lyinati 'to join')
Nepali	sutari	'string, rope'
	sut	'fibre, twine, string'
	sutli	'string, cord, strand, twine'
	sutlo	'piece of string, twine, or gauze'
English (Davies)	suture	'process of joining, by sewing; the material used, i.e., thread, gut; the line so formed'(Latin sutura)
Proto-Indo-European	*syu-	'to bind, sew' (*sū- in Germanic *saumaz in Old English seam)
English	sutra	'any of various aphoristic discourses or narratives in Buddhism and Hinduism (Sanskrit sutra, thread, string, collection of rules)'

Austronesian (Western)

(Indonesian)		
Proto-Austronesian	*zariŋ	'cord'
(Blust, 1976:47)	*taliS(1)	"
Malay	tali	'rope, string'
Sea Dayak	tali	" "
	tasi, nasi	'to make twine'
	nali	'to make rope'
(Philippines)		
(Reid, 1971)		
Bilaan, Sarangani, etc.)	tali	'string'
Tagalog	tali	"
	itali	'to tie, to join'
Bisayan	itala	" "
(Formosan)		
Saaroa (Stanley, mss.)	tali	'rope'

Austronesian (Oceanic)

(Micronesian)		
Marshallese	jālinlin	'string'
(Abo et.al. 1976)	jaljal	'loosen, unwind, unsnarl'
	jali	'kind of basket'
Woleaian	feotagiy	'to tie'
(Sohn, 1976)	faatali	'tie with string'
Chamorro (Topping)	tali	'rope, string'
Yap	tal	'rope, string'
Ponape	saal	'rope, cord'
(Melanesian)		
Espiritu Santo	vetali	'banana string'
(Codrington, 1974)		" "
Leper's Island	votali	" "
Maralana	vetal, vetel, ve'el	" "
Fijian	ndali	'rope, string'
(Polynesian)		
Tongan (Churchward)	putalinga	'plantain; cordage plant'
Maori (Williams, 1971)	tarī	'to plait, to weave'
	tari	'sieve; noose for catching birds'
	tari-kākāriki	'4-strand cord'
	tari-karakia	'8-strand cord'

Austronesian (Oceanic)

(Polynesian)		
Maori (Williams)	ri	'to tie'
	ripeka	'to tie across'
Hawaiian (Puku'i/Elbert)	lī	'to lace' (as shoes)
	kalī	'string'; 'long vine, spindle, spine, roll'
	kālinā	'long vine, as of sweet potato'
	nipe'a	'to tie together'
	nipu'u	'to tie knots'
	mali	'to tie, as bait to hook'
	mamali	'to tie'
	mali	'string'
	malina	'to splice, as rope'
Maori	roi	'knot, bond'
	roiroi	'bind, tie up'
Hawaiian	mālō	'taut, firm, straight, as a cord'
	malo'elo'e	'taut, firm, as a rope'

Austronesian (Western)

(Borneo)		
Ulkit	taraki	'rope, string'
Kajaman	talei	'rope, string'
(Indo-China)		
Atjinese	taloe	'rope, string'
Roglai	taloʔi	" "

Austroasiatic

Sakai	sŋroi, sŋrōy	'string'
Bahnar (So.Ea. Asia) (Benedict, 1976:13, 26-27)	talei	'cord'
Khasi	tɔlai	'cord'
Khasi (Rabel-Heyman, 1973: 1024)	tilay-suwali	'rope for plough'

Dravidian

Tamil	talai	'fastening cord, rope'
	talaiyam	'bonds, fetters'
	irai	'thread'
	inai	'to tie'
Bonda, Desia	gurai, guray	'to tie, roll up'
Marathi, Tulu	tali	'fetters, foot-rope for climbing palm trees'
Marathi	tala	'fetters, foot-rope for climbing palm trees'
Telugu	netari	'weaver'
	neta-purugu	'spider'
	neta	'weaving'
Kuwi	neh'nai	'to weave'
Kuwi	dōh'nai	'to bind, tie'
	dossali	" "
Gondi	dohtānā	'to bind, tie; weave a fish trap'
Tamil	ney_	'to weave'
	neyū	'a web'
	neyuni	'to weave, as a spider'
Kolarian	ney	'to weave'
Tamil	pinai	'to be joined'
	punai	

Austroasiatic

Vietnamese	nhện	'spider'
Thai	nɛn' pyŋ	'to be firmly tied, securely tied, tightly'
Nicobarese	henden nang	'web'
Semang	nangan	'rope'
	(<u>nangan</u> is a rope used in climbing, for fastening the ankles together while the inside of each foot is pressed against the tree)	
Thai	nang-nang	'snare, net'

Austroasiatic		
Bonda (Assam)	puglaʔŋ	'to be folded'
	puglaʔŋa	"
	apuglaʔŋa	"
Austronesian		
Proto-Malay	benang	'yarn, thread'
Tonga	lalanga	'to weave'
	lālana-a-Matuku	'mat'
	alanga	'rope, of boat, masts, sails, oars; tackle, tacking, rigging, gear'
Samoa	lalaŋa	'weave, plait'
Maori	raranga	'weave, plait'
Rarotonga	ranga	'to weave, to plait; to braid,. as in mat-making'
	raranga	
	rangaranga	
	rangaranga'i	'plaited'
Hawaiian	lanalana	'spider'; Great Spider (Lanalana)
	ulana	'plait, as a mat'
	nananana	'spider'
	nonanona	'spider; ant'
Easter Island	nanai	'spider'
	kupenga nanai	'cobweb'
Barito Dayak (Borneo)	tiŋkilagaʔ	'spider'
	taŋ kalagaʔaŋ	'spider'
Indo-Iranian		
Sanskrit	kilanga	'mat'
	kilinga	'mat'
	(kulay-a)	'web, tissue, mat'
Prakrit	vunaŋ	'weaving'

The Spider Ecliptic and the Hawaiian "Navigation Gourd" Compass

Invariably, as we consider the foregoing sets of data, we should be aware of the frequent association of cordage and weaving with the analogy of the spider net strung (or woven) across the sky. In this association the presence of knotting is an extension of the knotted cord into a celestial grid, as a netting of suspended web or as a basket. This element is perhaps the most important one regarding the sets of fiber words connected with weaving, whether of cloth, or of fishnets, or of basketry.

The spider is the weaver's deity, as Great Lanalana, "Great Spider," is to weavers of mats in Hawaii. This becomes Tukutuku-raho-nui (Great-scrotum-spider, an allusion to the belly parts from which threads are emitted), the sky deity who lets down his celestial net in which hang the stars at night, while during the day the sun courses from east to west and during the year north and south. These motions were plotted on the Hawaiian "navigation gourd" compass as "the pathway of the spider" (ecliptic), i.e. the apparent motion of the sun north and south of the equator. Lines marking the pathway of the sun at the equinoxes and the celestial equator (ke ala i ka piko o Wakea), the tropic limits north (ke alanui polohiwa a Kane, the dark black road of Kane) and south (ke alanui polohiwa a Kanaloa, the dark black road of Kanaloa) were burned in (pyrogravure method) on the gourd compass or "navigation gourd" described in instructions given by Kane-a-ka-ho'owaha, counsellor to Kamehameha the Great. No credence is given to claims by native Hawaiian scholars that this element in their astronomy, or navigation, was not influenced by western concepts of the celestial equator/ecliptic coordinate system

introduced after American missionary education at Lahainaluna Seminary (1834).

The "navigation gourd" compass in Hawaii is known from two sources: Samuel M. Kamakau's original report of Kaneakaho'owaha's diagram (Ka Nupepa Kuokoa, July, 1865) translated by W. E. Alexander (Hawaiian Annual, 1891:142-143), and also from Admiral Hugh Rodman's study of the principles of the use of the navigation gourd in the tradition of La'amaomao per the story of Paka'a (Rodman, Hugh, "The Sacred Calabash," Proceedings of the Naval Institute, August, 1927:867-872). Let us examine these in chronological order, Kamakau's first (Kane-a-ka-ho'owaha):

"Take the lower part of a gourd or hula drum (hokeo), rounded as a wheel, on which several lines are to marked (burned in), as described hereafter. These lines are called 'Na alanui o na hoku ho'okele' (the highways of the navigation stars), which stars are also called 'Na-hoku-ai-aina' (the stars which rule the land). Stars lying outside of these three lines are called 'Na hoku o ka lewa,' i.e., foreign, strange or outside stars.

"The first line is drawn from the 'Hoku paa' (North Star), to the most southerly of 'Newe' (Southern Cross). The portion to the right or east of this line is called 'Ke ala'ula a Kane' (the dawning, or the bright road of Kane); and that to the left or west is called 'Ke alanui ma'awe'ula a Kaneloa' (the much travelled highway of Kanaloa).

"Then three lines are drawn east and west (latitudinally), one across the northern section, indicates the northern limit of the sun, about the 15th and 16th days of the month Kaulua, and is called 'Ke

alanui polohiwa a Kane' (the black shining road of Kane). The line across the southern section indicates the southern limit of the sun, about the 15th and 16th days of the month Hilinama, and is called 'Ke alanui polohiwa a Kanaloa' (the black shining road of Kanaloa). The line exactly in the middle of the sphere (the drum, Lolo), is called 'ke alanui a ke Ku'uku'u' (the road of the Spider), and also 'Ke alanui i ka Piko o Wakea' (the way to the navel of Wakea).

"Between these lines are the fixed stars, 'Na hoku-paa o ka aina.' On the sides are the stars by which one navigates. The teacher will mark the positions of all these stars on the gourd. Thus he will point out to his scholars the situation of Humu (Altair), Keoe (Vega?), Nuuanu, Kapea, Kokoiki, Puwepa, Na Kao (Orion), Na Lalani o Pililua, Mananalo, Poloahilani, Huihui (the Pleiades), Makalii (the Twins), Ka Hoku Hookelewaa (Sirius), Na Hiku (the Dipper), and the Planets, 'hoku hele,' Kaawela (Jupiter), Hokuloa (Venus), Hokuula (Mars), Holoholopinaau (Saturn), Ukali (Mercury), etc.

"During the nights from Kaloa to Mauli (the dark nights of the moon), are the best times for observation. Spread out a mat, lie down with your face upward, and contemplate the dark-bright sections of Kane and Kanaloa, and the navigating stars contained within them.

"If you sail for the Kahiki groups, you will discover new constellations and strange stars over the deep ocean, 'hoku i ka lewa a me ka lepo.'

"When you arrive at the 'Piko o Wakea' (Equator), you will lose sight of the Hoku-paa (North Star); and then 'Newe' will be the southern guiding star, and the constellation of 'Humu' will stand as the guide above you, 'Koa alakai maluna.'

"You will also study the regulations of the ocean, the movements of the tides, floods, ebbs and eddies, the art of righting upset canoes, 'Ke kamaihulipu,' and learn to swim from one island to another.

"All this knowledge contemplate frequently, and remember it by heart, so that it may be useful to you on the rough, the dark and unfriendly ocean."

Kamakau, reporter of this tradition, is suspected of doctoring up the gourd compass instructions to match ideas gained from education in European navigation and mathematics courses at Lahainaluna Seminary where Reverends Ephraim Clark and Lorrin Thurston had written the texts, such as Anahonua, by which students were drilled in land surveying, trigonometry, and navigation by lunar distance calculations. Nevertheless, there are indigenous elements to the Kaneakaho'owaha celestial compass diagram that are not explained by European concepts. These are:

1. Use of a gourd (hokeo) as a concrete artifact to represent the sky.

2. Use of pyrogravure (burning in) to engrave the parallel lines and other markings on the gourd.

3. Use of native names for:

a. The hemispheres, the east for Kane and west for Kanaloa, the naming of which obviously implies the daily (diurnal) rotation of time, thus the "first line from North Star to Southern Cross", marks the local meridian at night through the poles from 0° to 180° and at noon when the sun comes to zenith.

b. The tropic limits north (Tropic of Cancer) and south (Tropic of Capricorn) as commensurate with time of the year (expressed as the days of the months).

c. The use of red color for diurnal rotation of the sun and black for the limits of the solstice stations of the ecliptic; red distinguishing thus the daily motion of the sun from east to west through the hemispheres, and black for the annual apparent motion of the sun.

d. The use of names for these "roads" or pathways as of the threads or cords (ma'awe) of the major connecting lines of a celestial grid spun by the "spider" (ku'uku'u) as an analog of the sun. (One must be familiar with how spiders spin their webs from their bellies. They will lay between two or more connecting points the first primary threads and the diagonals, along which they can move freely on the primary radials of the structure; then they will lay down the threads between these primary radials. These horizontals are covered with a sticky substance which traps the prey in the net).

4. The name of the equinoctial line drawn across the middle of the "drum" (lolo) as identified with the "road of the spider" (ke alanui a ke Ku'uku'u), as the central position of the ecliptic at the equinoxes, i.e., at the 'road to the navel of Wakea' (celestial equator). (Missing from the diagram is Ka piko o ka honua 'navel of the earth' (i.e. Earth Mother), the terrestrial equator; piko o ka honua also refers to one's position on earth, i.e., your place of birth; your meridian). The lolo (drum) refers to use of the gourd as the 'sound' of the god of time (Lono-i-ka-makahiki) whose form is the gourd; lolo also means brain, as in the expression, 'the sun stands over the brain' (kau ka lā i ka lolo), or when the sun casts no shadow at noon (the sun will do this at any locus only in the tropics, twice during the year); this means that the Hawaiians

You would also have to know the other details left out, but which were necessary to comprehend the full symbolic configuration and details of the navigation gourd symbolism, for example, that the orientation to the eastern horizon, commensurate with the rising point of the sun (Kane-'onohi-o-ka-lā), cuts the horizon circle to eight primary segments of the spider's overhead compass, which is reflected again to the horizon circle cut on the horizontal plane to eight primary segments of the wind compass, symbolized as the eight-legged "octopus" god, Kanaloa. Thus the term ma'awe 'ula or 'thread, cord', as of the spider's compass in the sky overhead is matched by eight tentacles of the ma'awe 'ula 'red track' of the tentacles, 'awe of Kanaloa below. The 'awe is the root of the banana hemp plantain of which Kanaloa's body is used to make cordage for rope. For this reason the banana plant has always been recognized as the important body of this god insofar as the making of rope for voyaging canoes and house-building is concerned. The weaving and also . tying of cordage links the overhead star compass principle of primary segmentation of the spider's net, i.e., the 'red path' (ala 'ula, ma'awe 'ula) of the sun (Kane) to the 'red-cord path' (ma'awe 'ula) of the wind compass god (Kanaloa) on the gourd vessel body of the god of time, Lono-i-ka-makahiki (i.e., the Ipu o Lono, Unu o Lono image suspended in the net (koko) in the hale mua men's eating house). These elements point to indigenous concepts in Hawaiian religion that could not possibly have been introduced from the outside; they are already inherent in the native Hawaiian system of religious motivation behind the gourd as it reflects the tripartite assembly of three gods and their associated roles in navigation: time, the movement of stars coordinated with two motions of the sun,

rotation (diurnal) and revolution (annual).

Indigenous traditions also tell us that the Hawaiian priests would mark the progress of the sun's motion along the horizon at the"eastern gate of the sun" (Ha'eha'e) between the stations of the "four wives of Kumukahi", cairns and pillars in Puna district at Cape Kumukahi; that they would also mark the sun's position at Ka-lā-kau, the "western gate of the sun" at the "taproot" (mole) of Lehua island (northeast of Ni'ihau, but west of Kaua'i), or observe on the island of Oahu the sun go south of the hill Kapolei in 'Ewa marking the winter solstice. To voyage across the equator was to "trample" (ke'ehi) the "diaphragm" (houpo) of Kane, whose "eyeball" was the sun. In a contrasting diagram from that of the gourd compass is the sky as a house, the "ridgepole" (kaupoku) of which is the local meridian drawn between the North Star and the Southern Cross, while to the four cardinal directions the roof is held up by the "pillars" (kukulu) marked by the "pillar" (pou) stars, i.e., zenith stars which when they come across your center of locus on the earth mark the "navel" (piko) of the earth, your birthplace and your stance on the ground, therefore stars which mark the sky and the ground (hoku i ka lewa a me ka lepo) per Kaneakaho'owaha's instructions on the gourd.

In New Zealand the native Maori speak less about spider tracks along the celestial grid net and more about "baskets" (kete), using the analogy from weaving as well, as of receptacles holding the stars:

"Hence it is that he (Tane) brought forth the stars. There were four baskets (or receptacles) into which the stars were gathered, and their names are as follows: Haruru, Taiaroa, Maemae, and Whiriwhiri. When he placed the stars in these baskets the following karakia (or

incantation) was recited...of each basket:

Haruru* te rangi i runga
Ka toro taku kete tapu
He whetu tukua ki te rangi
Io e, ko tana tama i wehea e...

Resounds the heavens above
My sacred basket reaches out
To spread the stars in heaven
O Io! his son, where is he?

Maemae and Taiaroa from the stars,
Behold my basket with its pendulous end,
'Tis a basket to enclose the miraculous,
Behold my basket with the pendulous end,
Even from Hawaiki.
Behold my basket with the pendulous end,
Containing the seed of the stars
Behold my basket with the pendulous end..."

(Best, Elsdon, "The Origin of the Stars," Journal of the Polynesian Society, Vol. 30 (1921):259-261).

*(Note: In Hawaii Halulu (cp. Haruru) is a great bird, the companion of Kiwa'a, bird of the canoe shed. Halulu temple is at Kaunolū, or the place where Lū (cp. Rū, a great ancestor of both Polynesians and Micronesians), the sky-propper (whose companion sky-propper is Ro/Lo), a great ancestor, holds up the sky on Lana'i. Lu (Ru) and Lo (Ro) as sky-proppers perform a function usually ascribed to Maui, who also as a culture-hero holds up the sky among other great deeds he also performs. Note also, the "spreading" (tuku) of the sky in this Maori chant is from tuku, motifs in the paneling woven as the decorative sides of the walls of Maori houses (cp. tuku 'catch in a net', 'web of a spider', ornamental lattice-work between the upright slabs of the walls in a native house'; acc. Williams, 1971).

Somewhat parallel to the "four baskets" of sky stars is the Southeast Asian tradition of the "four webs" of the great spider creators at four cardinal points of the compass:

"Then, as the waters still rose, four greater gods descended from the highest heaven, and brought with them four huge spiders. One spider was sent on the sea to the South, and it spun an enormous web all round itself, the web and the spider forming the Southern Island. That is the island in which we live, which we call our world. The other three spiders were sent to the North, to the East, and to the West. Each spun its web, so that the spiders (with their webs) became the Islands of the East, the North, and the West...In the middle of the islands a great mountain rose from the sea...the central pillar of the world... known as Mount Meru..." (Johnson, Rubellite K., The Kumulipo Hawaiian Hymn of Creation, 1981:37).

It is this "basket" (kete) or woven container with "seeds of the stars" that is the "compass" denoted by the term kaveinga, which implies woven basketry.

Polynesian		
Tuamotuan (Stimson)	kavēi	'to lash with fine cords'
	kave	'the thread of a fringe'
	kavekave	'ends, strands, threads, fibres of a cord, belt, or mat'
	mākave	'a fibre, strand; composed of several fibres'
Hawaiian (Puku'i/Elbert)	'awe	'strand, thread'
	'awe'awe	'tentacles' (as of banana plant, octopus)
	'awe'awe	'runners, as on a vine'
	ma'awe 'ula	'red cord, as of the road in the sky to the west, as of Kanaloa (octopus god, as of the wind compass and banana fiber)
Tuamotuan	kave	'tendril' (= 'ave)
	ave	'long hairs, as on dog's tail'
		' strip of pandanus used in making the popo ball for the pei juggling game'

Polynesian

Tuamotuan	kavēi	'to lash with fine cords'
	kavei	'to take as a guiding star'
	kave	'to take as a guiding star'
	kaveinga	'a guiding star, used to steer by night voyages'
	kavēnga	'a variety of small spider' (from kave)
	kaveinga	'the name given to Matarika and Takero because they ushered in the seasons'
	ave	'the tail of a kite'
	ave	'the tail of a comet'
	aveave	'multiple feelers...of squid, octopus'
	māve, maave	'to be let down, as hair, wisp of hair'
	makave, kave	'the thread of a fringe; a tendril'
	kavēnga	'a limb of the moon'
Rarotonga (Savage)	kaveinga	'guidance, that which conveys or guides, that which points the way
	kaveinga	'used also to denote a compass'
	te vairanga kaveinga	'the navigating stars of which nine are recorded in tradition viz.: tauira te marama tauira te etua tauira te kaveinga tauira rangi o Avatea tauira te ao 'etu kura nga ma'u 'okianga matanui
Hawaiian	ma'awe	'fiber, strand, thread, as of a spider's web'
Tongan	kave	'tentacle' (e.g. of cuttle-fish, feke). Cp. lave
	lave	'feeler, antenna; cp. malave, fakalalave
	kave'i	(v.t.) 'to swing'; cp. kakave, makave
	makave	(v.t.) 'to swing about, esp. of something dangling'
	kavei	(n.) 'handle or strap, etc., for carrying with; e.g. handle of basket, etc.'
	kaveinga	(n.) 'star or other object for which one steers; purpose, goal, aim, object'; cp. tukunga, fua
	tūkunga	(n.) what is steered for: kaveinga
	fua	(n.) direction in which a boat is being steered;poi of the compass; cp. tulifua, kaveinga, kapasa

The cited comparative forms represent, perhaps, a vowel change from /-ai/~/-ay/ to /-ei/~/-e/. Let us consider the following forms (excerpted from Johnson/Decker, 1982:251-252, 256, 291):

Polynesian		
Tahitian	mave	'to weave'
	tavai	'twined weaving'
	to ha'avai	'cane, banana (i.e., plantain fiber)
Samaon (Milner)	'āvei	'strap, cord'
Tuamotuan	vavāi kavai	'a variety of running vine, *Triumfetta* procumbens
Marquesan (Dordillon)	ha'avai	'cotton' (reconstructed: halavai)
	haha'avai	'cotton' (" : hahalavai)
Tongan	vavae	'cotton, kapok'
	vavae kona	'milkweed'
Proto-Austronesian (Dempwolff)	*labay (-bar)	'yarn, thread'
Austroasiatic		
Old Khmer (Cambodia)	canhvāy	'skein'
Modern Khmer	caŋva:y	'skein'
Laotian	say fay fay	'cord, wire'
Vietnamese	vai	'cloth, material, fabric, cotton cloth'
Muong Vietnamese	vai, (b)vay	'cloth'
	*hɔpay, pay, ʔay	'cloth'
Thai	phaafay	'cloth, cotton fabric'
	pujfaaj	'cotton fiber, cotton wool'
	fai	'cotton, *Gossypium herbaceum*'

By way of comparison, are there forms in Central/South American languages that, while roughly similar, combine the spider figure with weaving technology as we have seen with Polynesian twined weaving?

Amerindian		
Inca (Peru)	away way	'cloth' 'spider web'
Atakapa-Chitimacha	wari wayi	'to weave' 'to weave'

The foregoing is important information, if only to settle an important point of Hawaiian tradition with regard to the navigation gourd calabash that is overlooked in debate that slams the door on tradition, first of all, or continues to miss the important element of weaving, or of woven netting or fiber, or basketry that accompanies the navigation gourd. Stokes' rebuttal to Admiral Hugh Rodman mentions the artifact involved in the 'sacred calabash' debate:

"This 'sacred calabash,' as illustrated in Plate 48 of the <u>Proceedings</u>"(Naval Institute; August, 1927), refuting Rodman, "is a specimen (No.B, 6958) in the Bernice P. Bishop Museum, presented by the widow of the late J. K. Kalanianaole, Hawaiian delegate to Congress for many years. An engraved inscription in gold on the cover states, in Hawaiian, that the specimen was the 'wind-calabash' of La'amaomao, cared for by retainers of the kings Lonoikamakahiki and Keawenuiaumi, deposited in the royal burial cave in Keoua precipice, and recovered and given to the late King Kalakaua in 1883. <u>When recovered, it was encased in decayed wickerwork</u>"(italics mine)...

"...The legend of Lonoikamakahiki does not mention the 'wind-calabash,' but does refer to his 'travelling-trunk' of the type known as <u>hokeo</u>, in which were carried clothing and other valuables. <u>These wicker-encased hokeo</u> are well represented in the Bishop Museum collections, and agree in form, size, and fixings with the Admiral's 'sacred

calabash' in its original condition. The identification of the latter specimen may thus be established as the chief's 'travelling trunk.' (Stokes, J. F. G., "The Sacred Calabash," JPS, Vol. 37, No. 145 (March 1928): 75-87).

In the original tradition of the navigation wind-gourd calabash of La'amaomao, La'amaomao comes up to Hawaii on the canoe of Mo'ikeha as though he were a live person in control of the gourd, opening its cover to let out the winds when there are none, or shutting the gourd with its cover when there are too many. After years go by the gourd of La'amaomao is given to the Paka'a, son of Kuanu'uanu and his wife La'amaomao of a different generation. In the wind-gourd are the bones of La'amaomao, grandmother of Paka'a, and as the story unfolds, La'amaomao, mother of Paka'a has reached into the large hokeo which is the travelling-trunk and removes a smaller container:

"When La'amaomao finished talking, she opened the cover of a large gourd (ipu nui) and drew out a certain small gourd (ipu hokeo 'u'uku) smoothly polished which had been woven (ulana) tightly with 'ie (Freycinetia) cord with a cover (po'i) on top."

"Then she turned and said to her son: 'I give this gourd to you, as its name was your grandmother's name and mine also, and within it are her bones. When she was alive, all of the winds of this archipelago were her servants, beneath a marvelous power which she received, and she gathered all of the winds into this gourd, and they are still in this gourd until now, and their names were committed to her memory, those from Hawaii to Ka'ula, and when there was no wind, she would remove the cover and call the wind, and the wind would then blow, and when the cover was replaced the wind would cease, and this gourd was famous as the 'Wind Calabash of La'amaomao'."

"Before her death, she gave to me (charge) to put her bones into the calabash, that it was for me to care for her bones until the time that my child should be gotten, then I should give him (this) to care for, and since you are my only child, I now give to you the responsibility to fulfill the command of your extraordinary grandmother.

"You must care for this gourd for a long time, since it is a charge inherited from your ancestors with respect to this gourd... Before he sailed La'amaomao first taught Paka'a the names of all the winds, the prayers, songs, and chants (paha), until Paka'a had memorized them all. When La'amaomao had finished counselling her only begotten son, and when all of the winds were fastened in his mind, then Paka'a took this wind gourd and bound it by cord with all of his other effects (into the other calabash), so that he prepared to sail..." (Mo'olelo Hawaii o Na Kahu Iwikuamoo o Keawenuiaumi, Ke Alii o Hawaii, a o Na Moopuna Hoi a Laamaomao, Ke Kamaeu Nana i Hoolakalaka Na Makani a Pau o Na Mokupuni o Hawaii Nei a Uhao Iloko o Kana IpuKaulana i Kapaia o Ka Ipumakani a Laamaomao, 128 page mss., no date: 20-21; translated by R. K. Johnson).

Of what significance is the gourd tradition beyond Hawaii? One Cook Island fragment speaks of the 'ue kura ('red gourd', meaning gourd of value (kura 'precious') in the story of Rata, who refuses to take Nganaoa (cp. Nanahoa, in Hawaii; cp. Ka Ule o Nanahoa, Aldebaran in the Hyades), a wizard who flies kites, aboard. The wizard follows in him a large gourd that floats on the sea:

"At the time that the canoe sailed away there were only eleven men on board. The canoe sailed on until the land was out of sight, when the crew descried a large gourd floating on the surface of the

sea.' The crew threw Nganaoa and his gourd overboard, and left him to his fate (as they thought)."

"The canoe proceeded on its voyage, and had sailed on for some distance when the crew noticed another gourd floating on the ocean, they at once cried out, 'There is our ue-kura floating on the sea.' Rata heard them and called out, 'Pick it up.' They did so, and when they opened it they were again confronted by the glistening eyes of Nganahoa" ("The Rarotongan Version of the Story of Rata," JPS, Vol. 9 (1910):142-168).

Nganahoa is a priest, and with each crisis that the canoe confronts he floats out on the surface of the sea in the gourd to do away with the problem. The presence of the gourd calabash as floating in the sea is repeated in the Tuamotuan song:

> "Oh, my calabash!
> Blown toward me by the wind,
> My calabash rolls over and over on the toppling waves
> It is my diviner, giver of the wisdom of the stars.
>
> Oh, my calabash!
> Bringing me a brother's life-saving love,
> My calabash turns over and over on the crested waves.
>
> It is the first of my sacred possessions to be borne
> hither to my side,
> Drifting into my welcoming hands.
>
> Oh, my sacred calabash--
> Revealing the wisdom of the stars."
> (Stimson, J. Frank, Songs of the Sea Kings, 1957:75)

That the gourd was encased in basketry in Hawaii is clear in the case of the wind calabash of La'amaomao (Ipu Makani a La'amaomao), but the Ipu o Lono was suspended from a net (koko) as the important shrine (Unu o Lono) in the men's eating house (hale mua). The chant to this gourd goes as follows:

> "The gourd is placed in position; a shapely gourd it is.
> Plucked is the gourd; it is cut open,
> The core within is cut up and emptied out.
> The gourd is this great world;

Its cover the heavens of Kuakini
Thrust it into the netting;
Attach to it the rainbow for a handle!

Within this gourd from the cavern of Mu-a-Iku, calabash of explosive wind-squalls--till the serene star shines down

Take hold of it and it crouches; take hold of it and it displays itself at Vavau

Confirm this and make it sacred, wholly sacred, O Lono!
Bind it securely here." (Malo, 1951:89)

"This image had suspended from its neck a gourd, ipu, which was perforated to receive a wooden bail" (Ibid.:88). (This means that the larger gourd of Lono, the unu (temple), also carried the kā bailing cup, gourd symbol of the goddess Hina-ke-kā, the canoe bailer form of the moon goddess).

Except for occasional insights provided by tradition, the gourd compass is an artifact in navigation that remains unexplained. Judge by this Maori tradition how important was the basketry that accompanied the gourd:

"The Whanau Marama" (i.e., celestial lights, stars, moon, etc.) "were placed in baskets to be so transferred. The basket in which the sun was placed was named Rauru-rangi, that of the moon was Te Kauhanga, while that of the stars was Te Ikaroa (the Milky Way). Atutahi (Canopus) was not put in the basket, but hung or attached outside it; hence it still remains outside the Milky Way" (Best, Elsdon, The Astronomical KNowledge of the Maori:1978:11).

The Argument from Ethnoastronomy: Central and South America:

In a very important study by Cecelia Klein, "Woven Heaven, Tangled Earth; A Weaver's Paradigm of the Mesoamerican Cosmos," the concept of the woven and knotted cosmos is highly developed in

Maya cosmology:

"...The Yucatec Maya...Tizimin passage...reference to 'the stretching out of the earth'...evokes an image of the weaver who readies the warp cords on her loom...

"...The Aztec month Tititl, which it translates as 'Stretching,' for which it depicts a 'man as one who stretches something with a cord, in order to indicate that the gods thus stretch and sustain the machine of the world...

"Although the Mesoamerican cosmos has been described...it was constructed not of stone blocks, but of filaments...

"Both art and literature testify to a general Mesoamerican belief that the universe is bounded, defined, and contained by long, thin, essentially supple objects of a basically cord-like form. The primary identity of these strands varies, but the various types are typically cross-connected...the Chamula, for example, claim that their cosmos 'is bounded and held together by the circular paths of the sun and the moon...', and the Lacandon tell of the sun's daytime travels along a road in the sky..." (Klein, 1982:1-2).

"The Mesoamerican universe, then, was perceived, at least by some, as formed during the creation with pliant cords stretched out as on a giant loom...however...the celestial portion of the Maya universe, not as a loom, but as a house...

"...Zinacanteco house serving as a microcosm of the upper universe, its peaked roof thought of as layered and traversed by the sun, moon, and stars...

"...Aztec house facades...show that they were bound together with cords that form a diagonal cross...The concept of the upper universe as a house is by no means inconsistent with the postulated model of

weaving, since ordinary Mesoamerican houses are, even now, essentially woven. Wattle and daub structures, in particular, qualify here, since their cane armatures were literally constructed like fabric...walls of such houses referred to by Maya names that mean 'to be woven or braided,' 'to be interwoven as a braid or mat,'... Maya houses are measured and their parts matched by means of a stretched cord, a process that curiously parallels...the Popol Vuh reference to the Maya creation as time when 'the measuring cord was brought and...stretched in the sky and over the earth, on the four angles, on the four corners...Among the Aztec, these cords may have been made of <u>mallinalli</u>, a wild twining grass whose name derives from <u>malina</u>, 'to twist something'...

"...The celestial house, then, was conceived of as woven... The basic structural members were organized according to the geometric principle of the grid, in which vertical elements interweave with horizontal ones...During the day, only the sun passes through this vast expanse, traveling along a single road that is fundamentally straight. Only at night is that space crowded with the numerous twisting paths of the moon, stars, and planets, which must have been perceived as forming a giant tangled web or net...(Klein:4-6).

"The image recalls the operations of the mecatlapouhque, the Aztec diviners and healers who used bundles of tangled or knotted cords for their prognostications...among the Huichol, knots in a cord are untied one by one as each day of the peyote pilgrimage passes. The Aztec, as is well known, bound and cremated 52 reeds symbolizing years at the end of each 52-year 'century'...symbol...included a twisted and knotted cord" (Ibid:10).

"Aztec myth tells of the god Tezcatlipoca descending to earth

during the creation by means of a spider's thread, but the more common vehicle is a twisted or braided cord. The Maya said, for example, that, at the beginning of a katun, 'the rope shall descend, the cord shall descend from heaven...an Aztez poem reads: 'I tie a rope to the sacred tree, I plait it with eight strands so that I--a magician--may descend to the magical house' (Ibid: 16-17).

(I interrupt this interesting segment of her paper to mention the Hawaiian traditions of Kana, the rope god in Hawaii, and the snaring of the sun by Maui at Hale-a-ka-lā (House-of-the-sun), as there are interesting parallels here. Kana is a child born as a rope, and he is cast out of the house after birth as rubbish. Uli, his grandmother, sees this in a dream and immediately orders the cord grandchild brought to her. She puts the piece of rope into a calabash of water and it grows a fathom a day for forty days, and overall it grows no more than 400 fathoms. When it becomes too large for the calabash she takes it to the mountains where it outgrows the house. When taken out of the calabash and flung into the sky the cord becomes a spider. When needed it stretches from island to island and where it stands, a footprint of the god is left. Kana's name is the number prefix to counting by tens: kanalua (20), kanakolu (30), kanahā (40), etc. Its strands may be of kowali vine, banana 'awe fiber, and other cordage fibers. Kana is called the "stretching god").

(Maui takes the hair of his mother (Hina) or sister to make his braided hair rope with which to lasso the sun. He waits for the sun to rise and ties each of sixteen legs of the sun to the wiliwili tree on Haleakalā mountain. The braiding of hair rope is reminiscent of the 8-strand braided cord of the lei niho palaoa which chiefs wore

suspended from their necks, the palaoa being the ivory tooth of the sperm whale, a form of the god Kanaloa).

(Interestingly enough, the wiliwili tree around which Maui tied his lasso of human hair means "twisted", "twined", as cordage).

"There was a very special means of passage through the cosmos for those gods and men on whom the privilege was bestowed. The vehicle of transport was netted, plaited, or woven, and seems to have represented in sacred miniature the fiber universe of the Mesoamerican...

"Among some northern groups, the hoop represented the entire cosmos, but the Arapaho said that it stood for the sun as well. During the Arapaho sun dance, such a hoop was first set up on an altar and then wrapped and hung up on a pole at the back of the lodge... 'inviolably sacred'...

"By the end of the Late Post-Classic period, the magical object appears to have been transformed into a mat or a woven throne...Like the netted hoops of the Zuñi, Arapaho, and Huichol, moreover the Maya mat-throne was related to the sun..." (Klein, 1982:21-23).

The importance of weaving and knotting as an activity that supplied the analogy for the cosmos, as the study of Mesoamerican concepts by Klein shows, is connection of that activity to the knotted cord, of the basis of the cord as something that "stretches", i.e., measures, as in house-building, and which supplies the substantial material and resulting net-work or grid that pertains to verticle/horizontal tying and interweaving, as in basketry (hoops), and fabrication of tied/woven houses. In that light should the calendrical applications of the quipu cords in South America (Peru) be seen, per this description by archaeoastronomer Zuidema.

"The sidereal lunar count was important in the spatial and political organization of the city of Cuzco and its surrounding valley. Our data derive from a system of 41 directions, called _ceques_ ('lines'), which were established from Corichanca, the temple of the sun. Their purpose was two-fold; two functions that have to be distinguished sharply. _Ceques_ as sightlines toward the horizon enabled the Incas to give a topographical description of the valley, including data on mountains, rivers, springs, irrigation canals, roads and social divisions, and to make astronomical observations on the horizon. The position on 25 May (The first new moon after this date belonged to the month including the June solstice) was defined by a _ceque_. (...by means of a group of four pillars erected on the gentle slope of Picchu...a series of observations were made the ensuing thirty days (after 4 August)...The setting sun, moving at this time of the year from north to south, passed the northern pillar on 4 August, between the two central pillars on 18 August, and the southern pillar on 2 September. These thirty days defined the fixed period of a synodic month...)."

"The other purpose of the _ceque_ system was to obtain a calendar in the strict sense of the term, that is a count of the days in the year that is repeatable over the years. Calendrical reasons explain the way that the directions of the _ceques_ were established--not only by various markers in the terrain on or close to each of these directions...the markers...are called _huaca_ 'sacred'...each _huaca_ was worshiped on its own day...in this way, the _ceque_ system became a calendrical instrument."

"The numerical information contained in the _ceque_ system was

recorded on a quipu, a group of knotted strings, where a ceque probably was represented by a string and each huaca of the ceque by a knot...Cuzco was divided into four quarters or suyus, I, II, III, IV with nine ranked ceques in each...Each huaca has the space of one degree on a circle that represents one year" (Zuidema, R.T., "The Role of the Pleiades and of the Southern Cross and Alpha and Beta Centauri in the Calendar of the Incas," Ethnoastronomy and Archaeoastronomy in the American Tropics, Annals of the New York Academy of Sciences, Vol. 385 (1982):203-229.

The Distribution of Knotted Cord Tradition in Relation to Navigation Techniques in the Indo-Pacific

The foregoing discussion attempts to show that knotted cord and related corded artifacts of weaving and knotting (as in basketry, matting, tied and lattice-work house construction, etc.) are connected to sky symbolism. The role of the spider and spider's thread/cord/web/net in the Indo-Pacific is extensive. The knotted cord as a device of calendrical notation is present in a culture zone stretching over the Americas from Mexico (Yucatan Maya) to Peru (Inca, Quechua). The stretching cord, as an extension of the concept of the 'navel' cord of earth and sky, is a device with the absence of knots, for measuring out space for building. As a symbol it represents primary lines of location with respect to time, as the point of juncture between locus of observation and zenith on the central line that, as a great circle extension, girdles the celestial equator from the earth (at the equator) and into infinity. Stretched from north to south between the poles it represents the meridian. This is the first interstice in the celestial grid of space and time, the first and primary 'navel', that which belongs to the individual,

his point on earth, his "tie" to earth and sky at his center. This was a very sacred concept to the Polynesian people and no doubt to many other peoples on the earth, judging by global extension of the navel cord motif and theme in astrological mythology. The beginning of the basket spiral and the first opening of the celestial net is also at that juncture of the whole structure that relates individual space and time to the whole cycle of cosmic time wherein the individual and the universe are twined together as one progression of birth from cosmic time to present time to eternal time. The basket, the web, the knotted cord, the navel cord of time and space is a construct of the human mind to understand external structure. It is a rudiment of geometry that extends a point along a line from one center of control to the order from which several motions and cycles of solar, lunar, stellar, and planetary time can be grasped from earth, in a cord no longer than the span of a hand or as long as four hundred fathoms of braided human hair coiled into a pendant of whale's tooth around the chiefly Hawaiian neck and by which Maui lassoed sixteen legs of the sun, tying and twisting it around the world tree at the axis of the house of the sun on Mount Haleakalā. This is the riddle of Hawaiian time. They left us clues for answers to their great cosmic questions, and all that is left to do is to untangle the knots of the puzzle. How can we relate the navigation gourd basket to the knotted cord of calendrical calculation in the Indo-Pacific? The track of words for fiber and the tying of fiber, as of -li, has shown a trail from India westward and from the Indian Ocean eastward, from Asia northeastward across the Bering Straits into the Americas, and probably from the Indo-Pacific into the Americas, then outward again from the Americas into the Pacific, these last two migrations

datable, perhaps, to about 3000 B.C. Does the etymological evidence support a widespread, common or ancestral system of calendrical and navigational use of knots, cords, nets, baskets, and god houses by which to effect or to structure understanding of the cosmos?

Rig Vedic (Indo-European, i.e., Sanskrit traditions) history dates the "spider's path" as the ecliptic in India as early as 3550 B.C., the earliest appearance of that analogy in written literature, while the concept may have been earlier spread in oral folklore (Johnson, Rubellite K., Kumulipo (1981):41):

> "Ordaining the days and nights,
> Like a cunning spider,
> For six months south constantly,
> For six north the sun goeth"

Myths of the "Spider Creator" identify Anansi in Africa as a trickster type, as are Qat and Marawa in Melanesia; Emplawa Java, as the celestial spider deity of Java, is helpful to lost mariners, emphasizing the expected maritime aspect of Malay culture; Areop Enap in Nauru, and Nareau the Elder and Younger in the Gilbert Islands; in India, Makramal Chatri, tutelary deity of cloth and fishnet weavers courses along the ecliptic as do Great Lanalana and Ku'uku'u (Hawaii) and Tukutuku-raho-nui (Tahiti) over Polynesian skies. While male spider creators dominate that analog from Africa eastward, the female spider weaver who courses to earth from the sky on a cord brings loom technology to the American continent. This navel cord attachment which connects earth to sky is of world-wide distribution into classical times. The site of the Delphic oracle was one such 'navel of the earth,' patterned perhaps after the older 'navel' (thibbun) from which the city of Thebes in Egypt took its name.

We read: "Several geometrically minded cultures think it is

important to discover the exact center of the universe. The Zuni of New Mexico have several complicated migration legends about their search for the navel of the world. These are also connected with origin myths about their emergence from the womb of the world. The cities of Cuzco, Delphi, Delhi, Peiping,* and many others are at that particular geographical spot. The Greeks had a myth about it. Zeus, eager to discover the exact center of the earth had two eagles fly at exactly the same speed, one from the east and the other from the west. They met at Delphi. There in Apollo's temple (*i.e., temple of the sun) the Greeks set up an <u>omphalos</u>, a holy navel stone guarded by two golden eagles...They are in the shape of half-eggs on low quadrangular bases, sometimes artfully decorated...The boundary stones in the fields of southern India have generally the same shape as the omphalos and are also called 'navel stones'" (Leach, Maria, <u>Standard Dictionary of Folklore, Mythology, and Legend</u>, 1972:786-787).

To these navel cities add Easter Island, <u>Te Pito o Te Henua</u>, in Polynesia, which takes its name from 'navel' (pito) and 'placenta' (henua).

The knotted cord used as a sextant in the art of maritime way-finding has a more articulate tradition and visible historical use in the Indian Ocean. From the <u>al kamal</u>, identified as the instrument used by Arab sailors from the Gulf of Aden to the Straits of Molucca in Indonesia, the knotted cord sextant became the cross-staff, just as the Indonesian plumb line used in gnomonics became the notched stick for shadow-marking. The knot proportions on the Arabian <u>al kamal</u> were used to determine latitude by vertical angle to Polaris. Per the report by James Prinsep:

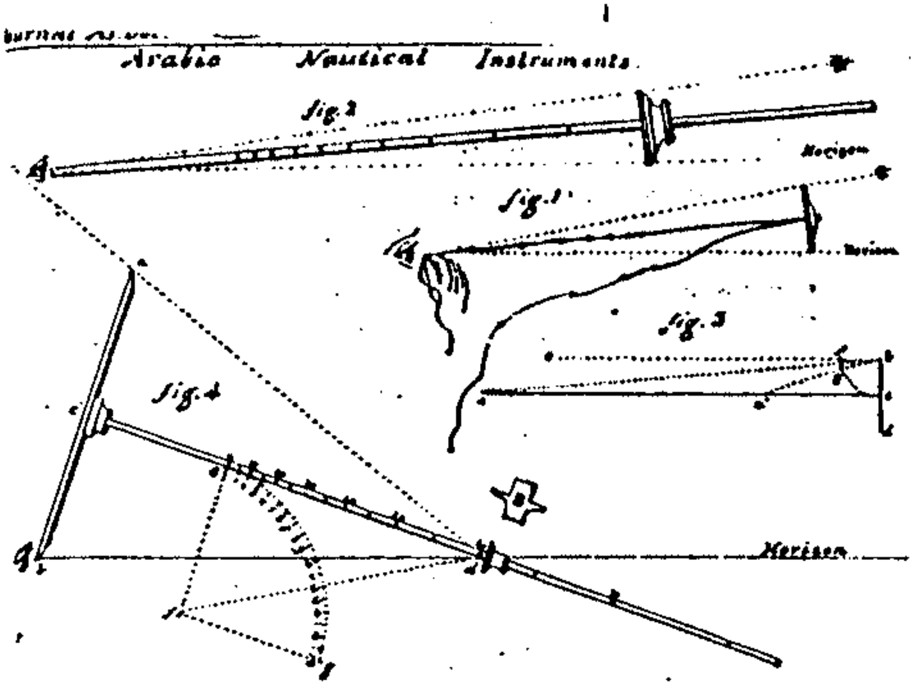
*(Note: See <u>Addendum</u>, page 62 <u>intra</u>).

"One Muallim, however, seemed to recognize the instrument perfectly by my description, though he could not explain its construction...he stretched out his arms, when I inquired about the issabah division and placing his fingers together horizontally, counted with them the height of the polar star, just as I guessed must have been the early and rude method of the Arab navigators." (*Cp. intra p. 26: Aymara (Bolivia) táhli 'measurement, four fingers wide; width of hand).

"At length in a vessel from the Maldive islands I met with an intelligent navigator who brought me the primitive instruments with which he was accustomed to work his way to Calcutta...they are of Arabic origin..."

"Fig. 1 is the kamal, an instrument for taking the altitude of the polar and circumpolar stars*(*the man assured me it was for taking the longitude...), in its most elementary shape" (Prinsep, James, "Nautical Instruments of the Arabs," Journal of the Royal Asiatic Society of Bengal, Vol. 5 (1836):784-787). (See diagrams, intra, p. 60).

The al kámal, patterned on the similar extension of the knotted cord (i.e., the ceque/huaca line and knot parallel) to the pole star in the Indian Ocean varies from the ceque/huaca principle in that it is a method to determine latitude by vertical angle to Polaris above the horizon, maintaining eye level to the horizon circle. According to Prinsep this knotted cord method, and therefore the cross-staff, grew out of the outstretched hand measuring methods of obtaining that angle of height from older, rudimentary measurements.



Prinsep, James, "Nautical Instruments of the Arabs," RASB, Vol. 5 (1836):784-785.

Fig. 1. is the كمال *kamál*, an instrument for taking the altitude of the polar and circumpolar stars*, in its most elementary shape.

It consists of a small parallelogram of horn (about two inches by one) with a string (or a couple of strings, in some instances), inserted in the centre. On the string are nine knots. To use the instrument for taking the height of *polaris*, the string is held between the teeth, with the horn at such a distance from the eye, that while the lower edge seems to touch the oceanic horizon, the upper edge just meets the star: the division or knot is then read off as the required latitude.

The mode of marking off these knots is curious. Five times the length of the horn is first taken, as unity, and divided into twelve parts: then at the distance of six of these parts from the horn, the first knot is made which is called "12." Again the unit is divided into eleven parts, and six of these being measured on the string from the horn as before, the second knot is tied and denominated "11." The unit is thus successively divided into 10, 9, 8, 7, and 6 parts, when the knot tied will of course exactly meet the original point of five diameters: this point is numbered "6." Beyond it one diameter of the horn is laid off for the "5" division, and one and a half again beyond that for the "4" division, which usually terminates the scale.

It is easy to determine by calculation the value of these several divisions, measured from the centre of the horn or diameter *b d*, and at right angles to it. They represent the tangents of the angle *c b a*, to radius *b c*, or cotangents to the complementary angle *c b a*: but *c b a* is equal to *b a c*, which is half of *d a b*, therefore the divisions represent cotangents of half the angle of observation. To judge then of their actual value, expressed in altitude, we have but to convert their numerical ratio to radius, by a table of natural cotangents, into degrees and minutes; and to take the double as the latitude in each case: thus, the horn being equal to double radius *b c*, we have

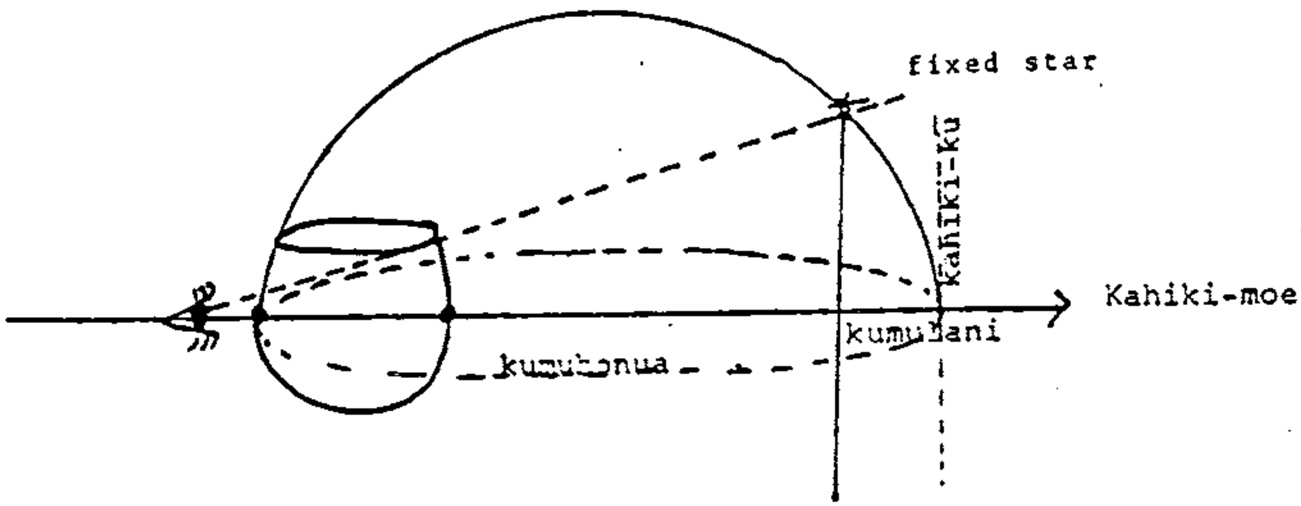
				Lat.	Diff.
The first division, No.	12	= 2 × 5 ÷ 12 × 6	= 5.00	22°38′	1°52′
	11	10 ÷ 11 × 6	5.45	20 46	1 52
	10	10 ÷ 10 × 6	6.00	18 54	1 50
	9	10 ÷ 9 × 6	6.66	17 4	1 53
	8	10 ÷ 8 × 6	7.50	15 11	1 53
	7	10 ÷ 7 × 6	8.57	13 18	1 54
	6	10 ÷ 6 × 6	10.00	11 24	1 52
	5	10 + 2	12.00	9 32	1 56
	4	10 + 5	15.00	7 36	

(Cotgs. of half angle.)

It will be seen by the last column that the harmonic progression of the divisions obtained by this simple rule, agrees very closely with

* The man assured me it was for taking the longitude, and promised to come one night and use it in my presence, but failed.

In that light, the sextant principle in the Hawaiian tradition of the "sacred calabash" as employed by Admiral Hugh Rodman may be reconsidered as not completely untenable, as those instructions from native Hawaiian tradition employ the same principle of observation and measurement from eye level to horizon with Pole Star tangent to the height of the "horn" (in this case the height of the side of the gourd) to give the angle by which latitude may be determined:



To summarize: The knotted cord and related corded artifacts scattered through the region of the Indo-Pacific and used variously for navigation and calendrical computation, including a wide distribution of similar terms for the artifact and process of tying and knotting, argue in favor of diffusionary penetration and probable exchange between Pacific cultures, more than likely Polynesian, and South America. The association of these artifacts with religious and cosmic ideas, such as the spider ecliptic, allied with the technology of weaving, increases the likelihood of association, if not kinship.

/¯ADDENDUM/:

Comparable forms in Chinese for the assembled information on the word maps (Map 4, page 23 <u>intra</u>) showing distribution of <u>-li</u> 'to tie':

Tibeto-Burman		
Chinese (Wieger)	li^2	'rope, cable' (Wieger:564)
	$liao^2$	'to bind, wrap' (Wieger:538)
	lei^3	'to bind, tie' (Wieger:525)
	$lien^2$	'to connect, to join' (Wieger:526)
	li^4	'astronomy, calendar' (Wieger:560)
	li^4	'annual cycle' (Wieger:284)
	$p'u^3$	'chronicle, register, catalogue' (Wieger:549)
	ta^2	'a knot' (Wieger:550)

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Maneaba

The Gilbertese *maneaba* is the centre of communal life, the council chamber, the dance hall, the feasting place of the gathered totem groups comprising any local population. As such, it is sacrosanct; no brawling or dispute may take place under its roof, or upon the *marae* (open space) of which it is the centre; its supporting pillars may not be struck; and only games of a definitely religious or social significance (including above all the dance) may be played within its precincts.

The building is susceptible of offence, and may not be spoken of in jest; he who offends it becomes *maraia* and liable to sudden death or sickness. It consists of an enormous thatched roof, whereof the eaves descend to within six feet or less of the ground, supported upon studs or monoliths of dressed coral rock. The largest of these buildings at present in existence has an interior length of 120 ft. a breadth of 75 ft., and a height from floor to ridge-pole of 45 ft. There are three main types of *maneaba*: that called Tabiang, whereof the breadth is equal to about half the length; that called Tabentebike, or Te Tabanin which is four-square; and that called Maunga-tabu, whose breadth is to its length in the proportion of about 2:3. All have hipped or gabled, not conical, roofs.

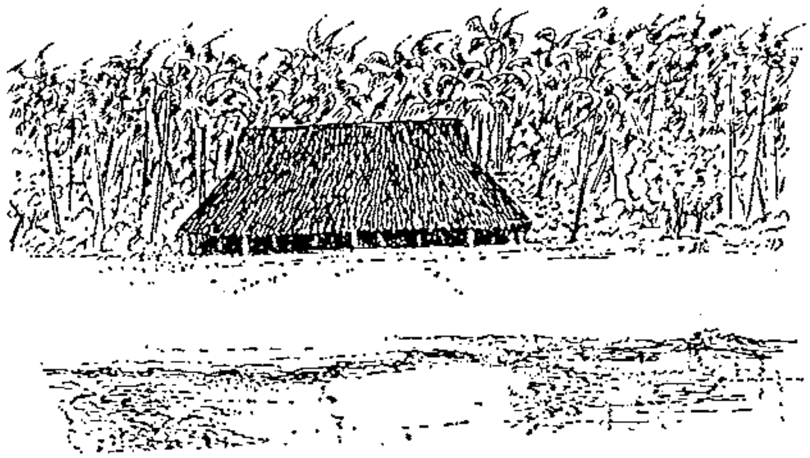
Each totem-group has its hereditary *boti* (sitting-place) in the *maneaba*, and its peculiar functions or privileges in connection with the building of the edifice, or its maintenance, or the ceremonials which take place beneath its roof. To usurp the *boti*, privilege or function of another group is to become *maraia*.

The Maunga-tabu *maneaba* is called by the Karongoa group 'the enclosure of the Sun and Moon', and the Sun is believed to take vengeance upon any who violate or offend its precincts. Supporting the roof-plate in the middle of the eastern side of this building is a stud named 'Sun', against which the people of Karongoa-n-uea (Karongoa-of-Kings) have their hereditary sitting place. Opposite the 'Sun', in the middle of the western side, is the stud named 'Moon', against which the clans of Ababou and Maerua are seated. Karongoa, Ababou and Maerua have the Sun-totem in common and share the monopoly of the Sun-Moon fructification ritual.[1]

All ceremonial and all speech in the Maunga-tabu *maneaba* are subservient to the will of Karongoa-n-uea, as enunciated by the senior male of that group. This individual is called 'Sun in the *maneaba*', and it is believed that the Sun will pierce the navel of any who contradicts him, questions his judgment, expresses the least doubt about his rendering of a tradition, or attempts to usurp any of his privileges within the sacred building. The Karongoa-n-uea spokesman wears on his head a fillet of coconut leaf called *buna-n Taai* (the fillet of the Sun). On ceremonial occasions he sits alone, slightly in advance of his fellow clansmen, and opens proceedings—after silence has been called—by muttering the magico-religious formula called *te taematаao*, 'to clean the path of his words', and so protect him from interruption or contradiction. The formula is recited three times with the head bowed, while the hands are slowly rubbed together, palm on palm; after three repetitions, the performer throws his hands forward, palms up, elbows against body, and raising his head exclaims, '*E oti Taai*' ('the Sun appears') or '*Aria-ia ba ti na ongo*' ('take it up for we will hear'), after which the ceremonial or debate proceeds.

The sib of Karongoa-raereke is the companion and acolyte[2] of Karongoa-n-uea in the Maunga-tabu building; its members carry messages from the sacred clan to other groups and, in the Northern Gilberts, its elder 'lifts the word from the mouth of Karongoa-n-uea', i.e. announces to the assembly the whispered oration or judgment of the Karongoa-n-uea spokesman. The privilege of Karongoa-raereke is to take a share of the first portion of any feast, which is the perquisite of Karongoa-n-uea. Its duty is to supervise the laying and maintenance of the coconut-leaf mats (*inaai*) with which the floor of the *maneaba* is covered, and to perform magico-religious rituals for preventing dissension in the sacred edifice. The time for such rituals is the hour when the Sun is approaching his zenith; and among the material used is a *kuo-n-aine*—a cup made of half a coconut shell wherein oil has been boiled. This vessel is said to have formed the magic boat of the Sun-child Bue, ancestor of the Ababou clan, on his voyage to the Sun.

1 This ritual is described in Chapter 1, pp. 21–5. (R.G.)
2 The Gilbertese word is *Tabonibai* which means 'finger', that is to say 'servant'.



Ababou and Maerua

The Ababou and Maerua groups claim both the Sun and the Moon as their totems, and are seated about the stud called 'Moon' in the middle of the western side of the *maneaba*. The ceremonial function of Ababou is to separate the first portion of Karongoa-n-uea from any food brought to the *maneaba* for the purpose of a feast, and to hand it over to Karongoa-raereke for conveyance to the sacred clan.

The clan of Te Wiwi claims the function of blowing the conch (*bu*) which announces a gathering in the *maneaba*. Members of the Keaki group have the right to prior entry into the building, in the sense that when one or more of them arrives in a crowd at the *marae* upon which the *maneaba* stands, their companions of other clans (excepting Karongoa-n-uea) will stand aside to let them pass.

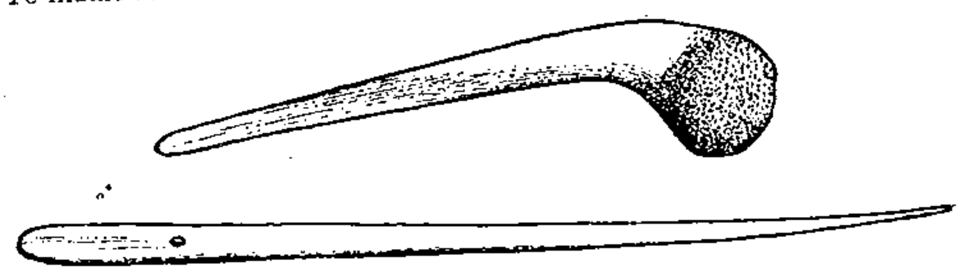
The elder of the Tabukaokao group supervises the collection of food for any feast, in the middle of the *maneaba*, and shares with the elder of Ababou the right of dividing it into two equal portions—one for the northern the other for the southern half of the building. Ababou then separates from the northern half the first portion of Karongoa-n-uea, which is issued before any further distribution is made. Karongoa-raereke carries the first portion to Karongoa-n-uea, and other specific groups have the right of dividing and distributing the remainder.

Outside the *maneaba*, Ababou and Maerua claim the power of making and unmaking eclipses of the Sun or Moon, of rain-making, and of raising or stilling the wind. These powers are said to be inherited from the hero Bue who was a child of the Sun by a virgin mother. But the Sun's greatest gift to Bue was the craft of building *maneabas*: 'The *maneaba* of Kings, which is called Te Namakaina (Moon); and that called Te Tabanin (The Foursquare); and the *maneaba* whereof the breadth is greater than the length, called Te Ketoa'. It is by virtue of this gift that the clans of Ababou and Maerua lay claim to what is their pre-eminent function, namely that of being, on behalf of Karongoa-n-uea, the master-architects of the Maunga-tabu building.

Their duties in this direction are to find a suitable site for the edifice, to lay out its ground plan, to order the position of all its timbers, and with their hands to cap its ridge with a covering of plaited leaf or matting. Their acolytes in these works are the Eel-totem group of Nukumauea and the Crab-totem group of Tabukaokao. In all their building rituals, the names of Sun and Moon are pre-eminent; they believe that the Sun dwells in the Maunga-tabu *maneaba* because he was the originator of that style of building, and that he will take vengeance upon any person who either offends the edifice or attempts to usurp the functions or imitate the rituals of the builder-clans.

The posts of dressed coral which support the roof of the Maunga-tabu are set up to the accompaniment of a Sun formula. The first timbers to be cut and dressed are the *tatanga* (roof-plates). The heavy work is done by the acolyte Eel and Crab totem groups, but before the dressing of the rough logs begins they are heaped in a pile for ritual treatment by the master-architect of Ababou. Before noon, on a day when the sun and moon are seen together in the sky, the master mounts the pile and, facing east, taps one of the logs lightly with an adze, intoning:

Ba N nangi tiba koroi-a, tatanga-ni maneaba-ia Taai, Namakaina;	*For the time has come for me to cut the roof-plate of the* maneaba *of the Sun and Moon;*
Ba maneaba-ia Auriaria, Nei Tevenei, Riiki, Nei Tituaabine.	*Even the* maneaba *of Auriaria, Nei Tevenei, Riiki, Nei Tituaabine.*
E toki tera? E toki te bakarere.	*What ceases? Violence ceases.*
E toki tera? E toki te kai-n-anti.	*What ceases? Evil magic ceases.*
E toki tera? E toki te maraia.	*What ceases? Being under a curse ceases.*
E toki tera? E toki te tiringaki.	*What ceases? Being smitten ceases.*
Etoki-i-i, e toki-e-e-e,	*It ceases, it ceases, it ceases, it ceases.*
Te mauri ao te raoi.	*Prosperity and peace.*



The cutting of the rafters and other scantlings is preluded by exactly the same ritual and formula, the word *tatanga* (roof-plate) being replaced by the ap-

propriate term. When the thatch is complete, the ridge capping is laid in position and, again before noon, both sun and moon being seen in the sky, the master-architect mounts the roof armed with a thatching awl. Sitting on the ridge facing east, midway between the gable ends, he stabs the capping with his awl on either side of him and intones:

Ba N nangi tiba ewari-a,	*For I am in the act of piercing it,*
Taubuki-n uma-ia Auriaria, Nei Tevenei, Riiki ma Nei Tituaabine.	*The ridge of their dwelling, Auriaria, Nei Tevenei, Riiki and Nei Tituaabine.*
Ririka-n uma-u tera? Te karau.	*The covering of my dwelling from what? From rain.*
Ririka-n uma-u te buaka;	*The covering of my dwelling from storm (or strife);*
Ririka-n uma-u karawa;	*The covering of my dwelling from heaven;*
Ba rokiroki-n uma-ia Taai ma Nama-kaina.	*Even the screening in the house of the Sun and the Moon.*
Te ririka-e-e, te ririka-o-o!	*The covering-e-e, the covering-o-o!*

This formula having been recited three times, the master architect descends, and the ridge-capping is sewn in place by workers of Ababou and Maerua.

When the work is complete, the officiator again mounts to the ridge, carrying with him four coconuts in their husks. For the purposes of the ceremony these nuts are secretly known as *ata* (human heads). Straddling the north end of the ridge, facing south, he strikes off the proximal end of one nut and, sprinkling its liquor over the capping, mutters in a low voice the following formula three times over:

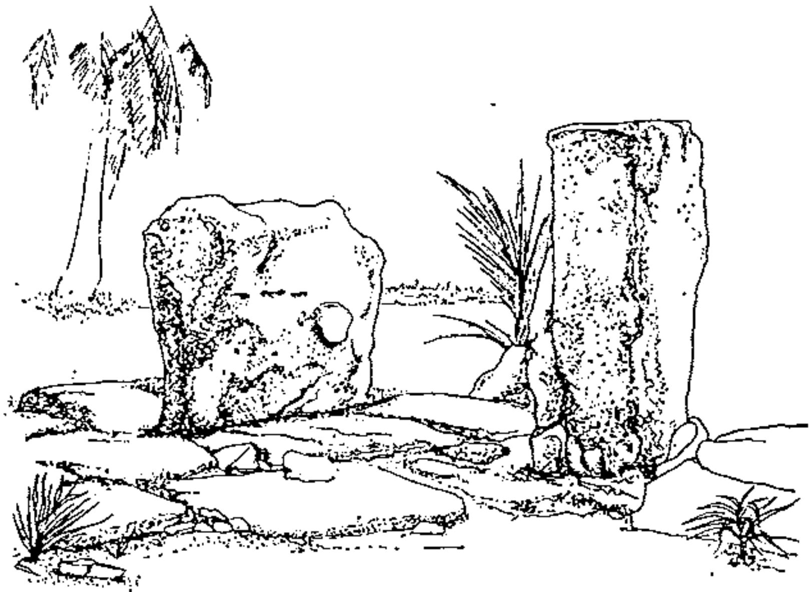
Bubu-n ai i Aba, bubu-n ai i Abaiti,	*Smoke of fire at Aba, smoke of fire at Abaiti,*
Bubu-n ai i Maunga-tabu, bubu-n ai i Ababou,	*Smoke of fire at the Sacred Mountain, smoke of fire at Ababou,*
Bubu-n ai irou.	*Smoke of fire with me.*
Timtim te rara:	*Drip-drip the blood:*
Taai, Namakaina-o-o, ko kaakangi kana-m te rara!	*Sun, Moon-o-o, thou eatest thy food, the blood!*
Matu, matu, anti ni kamaamate;	*Sleep sleep, spirits of killing;*
Matu, matu, anti ni kaaoraki;	*Sleep, sleep, spirits of sickness;*
Matu, matu, anti ni kamibuaka;	*Sleep, sleep, spirits of evil dreaming;*
Matu, matu!	*Sleep, sleep!*
Baraaki te unene,	*Overturned is the . . .*
B'e bung te aba.	*For the land gives birth.*

Proceeding now to the middle of the ridge, he repeats the same ritual, facing first east and then west, using his second and third 'heads'. He finishes at the south end, facing north, using the fourth head.

As each head is emptied of its blood, it is allowed to roll down the thatch of the *maneaba* to the ground below, where its position is anxiously noted. If the majority of *ata* lie with the open end (corresponding to the neck of a human head) pointing towards the *maneaba*, it is a sign of good fortune; but war, sickness or famine are prognosticated if the distal ends are presented to the building.

Chapter nine

Astronomy and navigation



We know that stone circles, in Britain and elsewhere, were laid out some 4,000 years ago as instruments by which men could observe the heavens to predict eclipses and movements of sun, moon and stars. These circles were so sited that alignments between heavenly bodies and certain landmarks met within the perimeters of stone. There they formed geometrical patterns illustrating mathematical concepts so advanced as to be incompatible with stories of a primitive prehistoric society.

From China, India, Egypt, the Euphrates valley, parts of Africa and Central America comes other evidence that many thousands of years ago there existed a civilisation of an intellectual and moral quality inconceivable to us today . . . The cultural void which today renders so much effort futile is no inheritance from the past. The great civilisation which declined and was lost some 3,500 years ago was based on the memory of a great vision through which all men had access to a state of enlightenment . . . They knew the places where the rise and fall of heavenly bodies could be interpreted in geometric forms and from these into mathematics and poetry.

They lived in absolute certainty, following in all they did the rhythm of the stars until, as memory began to fade, a vast system of oral traditions began to replace what hitherto all men had known. As guardian of these traditions a body of priests came into being. Under their influence the universal civilisation began to break up, rival groups of interpreters leading their followers in different directions . . .

When I read these passages in an article by John Michell,[1] on Alfred Watkins and mystical lines of force which gird the earth, I was reminded of ideas about the origins and migrations of the Gilbert Islanders which my father often thought about, but which the rigid disciplines of scholarship would not allow him to enlarge upon without more concrete evidence. He too had spoken about a universal civilization from which all might have sprung some 5,000–6,000 years ago: of customs, traditions and habits of thought, of morals and manners so similar that they could scarcely have arisen independently in unrelated races. The possibility of links between the Gilbertese and ancient Egyptian, Babylonian or Chinese cultures intrigued him particularly, and among his notes one sometimes came across odd jottings such as this:

Creation myth—sky, sun, and moon

1. Note that creation of Sun and Moon from the eyes of Na Atibu or the stingray in Gilbertese myth is similar to the creation of these luminaries from the eyes of Khepera in the Egyptian myth quoted by Spence in *Int. Myth.* pages 163–4.
2. In late Pyramid texts the sky is rectangular, each corner resting on a pillar. In still later times those four pillars were looked upon as the sceptres of the gods who presided over the four corners of heaven (Spence, *Int. Myth.* p. 165). Cp. Gilbertese myth of the four women called to support the four corners of heaven.
3. The Egyptian early sky was a flat metal slab. The universal Polynesian idea of sky was like 'blue rock'. Gilbertese, simple rock. Cite Na Area's tabunea (magic).
4. Babylonian myth: Merodach decapitated to make man from his blood and bone. Cp. Gilbertese myth of Na Atibu slain by his son to make sun, moon, stars and the Ancestral Tree whence all men grew. Cp. also the Chinese creation myth, in which the deity P'an Ku, who sprang from the four original elements, supplied his eyes to be sun and moon, and his breath, hair, flesh and sweat to be wind, vegetation, earth and rain.

Again and again he found evidence of this connection with ancient cultures which convinced him that the Gilbertese were descended from a highly civilized

1 In a paper originally delivered to the members of 'Contact', U.K., at a meeting on 24 February 1968 and subsequently published in the magazine *Albion*, London, vol. 1, no. 1, pp. 8–13.

race who understood the fundamentals of celestial navigation. In articles published in 1931 and 1945[1] he put it like this:

There was no word for 'astronomer' in the Gilbertese language. If you wished to find an expert on the stars you asked for a *tiaborau* or navigator, astronomy being looked on as only an adjunct to the larger science of navigation. This made it difficult to get reliable information on Gilbertese astronomical observances because, with the arrival of European ships and easy travelling, followed by Government regulations controlling inter-island canoe voyages, navigation had become a dying art.

Of the thirty thousand inhabitants of the Gilbert Islands in my time, less than twenty could speak with authority about the stars; and those who had the knowledge were often unwilling to pass it on, for of all secrets those connected with navigation were the most jealously prized and guarded. Nevertheless, there were still greybeards in the group who had made voyages of a thousand miles in canoes sewn together with string; and until some thirty years earlier, inter-island trips of two hundred and fifty miles and more were regularly made in these craft for the purpose of exchanging dances!

What I finally learned—especially certain facts connected with movements of the sun—made it clear that the Gilbertese ancestors came into Oceania equipped with a system of navigation based on the observation of heavenly bodies, and that they had learned it from people possessed of a mathematical system. Most of my information came from Biria, an old man of Butaritari, who sixty years before had been instructed in navigation. His training lasted seven years, during which time he learned to drink sea water—a little every day—until his body became so accustomed to it that he could live for weeks on end without any fresh water at all.

He also learned about the stars, but not under the sky; his lessons began in the village *maneaba* where he was made to sit at the base of the central pillar facing the eastern slope of the roof. Just as the roof was divided by lines of rafters, so the heavens were plotted out for him in lines of principal stars. Every

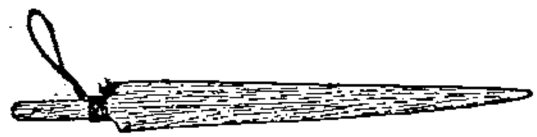
1 But probably assembled much earlier. I cannot resist quoting again from one of H. E. Maude's letters:

'. . . He was usually hard up when on holiday in those days and wrote anything, even cross-word puzzles, that would bring him in an honest fiver.

Your mention of *Gilbertese Astronomy and Navigation* reminds me of the day I found it. For some reason he used to take his salary, less the family remittance, in cash each month rather than have it sent to a Sydney bank like the rest of us. This money he used to keep loose in the right-hand bottom drawer of his desk and one day he told me to take enough to pay Kireua, the cook.

In the drawer, needless to say open with money all over the place, I noticed a file labelled "Gilbertese Astronomy and Astronomical Observances" and sat on the floor there and then till I'd read it through. Later Kennedy and I took it along to your father and besought him to publish it, but all he would say was that he had written it and once he had written anything he lost all interest in it (which was perfectly true). Eventually, however, he agreed and I think he was quite happy when it came out.' (R.G.)

constellation was allotted its imaginary place in the thatch, according to what we would call its angular distance east or west of Rigel and its declination north or south of that star.



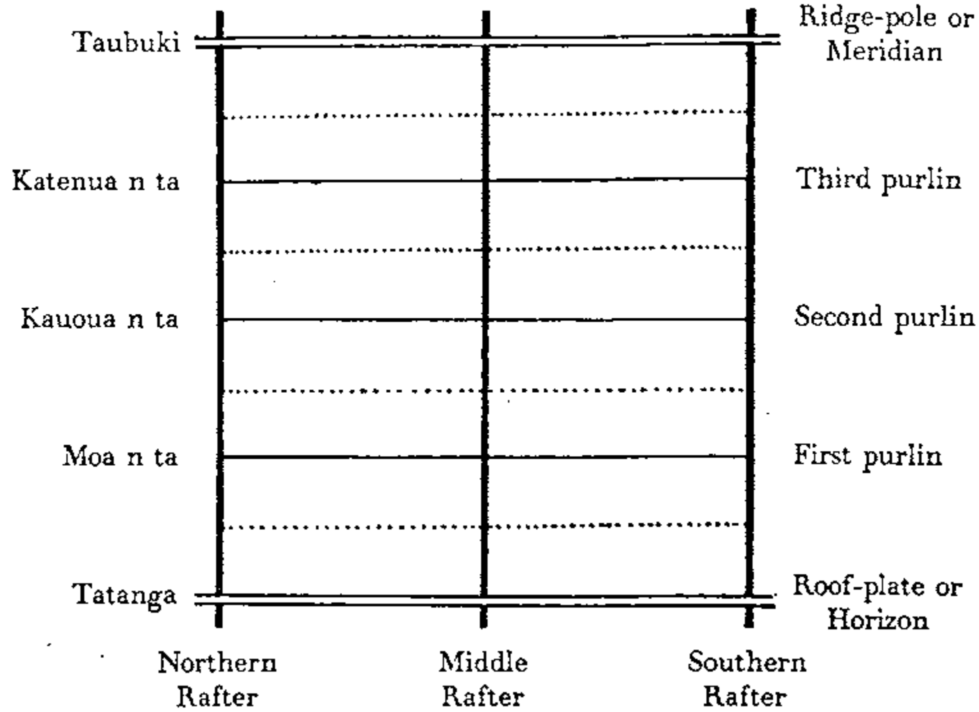
Aspects of the heavens

The Gilbertese navigator regards the night-sky as a vast roof. He never calls it *karawa*, the usual term for the heavens, but applies to it the special name *uma ni borau*, which signifies literally 'roof of voyaging'. His whole terminology of the skies follows consistently upon this fundamental idea. He calls the eastern horizon *te tatanga ni mainiku* (the roof-plate of east) and the western, in a similar manner, *te tatanga ni maeao* (the roof-plate of west). The meridian is *te taubuki*, the ridge-pole.

The roof is supported by imaginary rafters (*oka*), three on the eastern slope and three to correspond on the west. The apex of the middle pair is held to be at the point where the star Rigel (beta Orionis) crosses the meridian. These middle rafters represent the Gilbertese celestial equator, which, being fixed by the declination of Rigel, is seen to be placed about 8° south of our own. The apex of the northern pair of rafters is said to be where the Pleiades cross the meridian, which is about 24° north of the true celestial equator and 32° north of the Gilbertese; while the star Antares (alpha Scorpionis) marks the meeting-point of the southern pair at 26° true south declination, or 18° south of the Gilbertese equator.

Lying across these rafters, like the steps of a ladder up the sky, the astronomer imagines a series of three equally spaced cross-beams or purlins on each slope of the roof. The following diagram, then, illustrates his conception of the eastern sky from horizon to meridian.

His idea of the western sky is exactly the same, but he numbers the purlins downward from meridian to horizon. The navigator sits in imagination beneath this immense framework, upon which the stars themselves form the ever-shifting thatch. It is by reference to the purlins that he expresses the altitude of a heavenly body above the horizon, while the rafters afford him a rough measure of declination. For greater accuracy in indicating altitude, each of the intervals between the purlins is divided into two compartments, as shown by the dotted lines in the diagram. The eastern half (i.e. the lower half on the eastern side and the upper half on the western side of the roof) is called *te marena ni bong* (the interval of days or seasons) and the western half is *te nikaneve* (the sacred

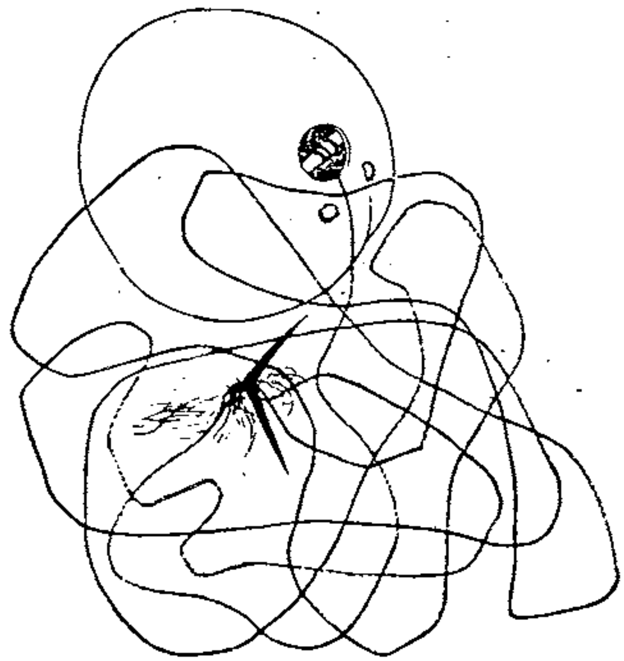


enclosure). The *marena ni bong* is said to 'belong to' the purlin bounding it to eastward, and the *nikaneve* to that which defines its western limit. In the diagram of the eastern sky above, the inferior half of each interval is therefore a *marena ni bong*, and 'belongs to' the purlin beneath it; while the superior half is a *nikaneve*,[1] and belongs to the purlin above it. From this it is seen that the various stages in the passage of a star from horizon to meridian are indicated as follows by a Gilbertese navigator:

1. The star is in the *marena ni bong* of the *tatanga*, or horizon;
2. It is in the *nikaneve* of the first purlin;
3. It is on the first purlin;
4. It is in the *marena ni bong* of the first purlin;
5. It is in the *nikaneve* of the second purlin; and so on until it culminates at the ridgepole or meridian. Thence its decline to westward is similarly expressed:

1. It is in the *marena ni bong* of the ridge-pole;
2. It is in the *nikaneve* of the first purlin to west;

1 *Nikaneve*: any sort of enclosing wall or screen erected around an object to prevent intrusion. Ancestral skulls might be thus enclosed; a high chief would sometimes sit in a nikaneve at a ceremonial gathering. The erection of such a fence was always accompanied by magico-religious ritual, with the object of bringing calamity upon an intruder.



of such stones on the island of Arorae has been described by Captain Brett Hilder, who studied them in detail in 1957.[1]

Navigators could also tell by eye, within half a degree or so, when a star was exactly overhead. They did this by lying on their backs on the outrigger platform and gazing fixedly up at the star, or by turning round and round as they stared upwards; when they could no longer see any difference in the star's angular altitude, whichever way they turned, it was at the zenith. They knew and memorized the stars which passed exactly over certain islands and would then endeavour to keep directly beneath them as they approached the islands. On ocean voyages they may also have been able to estimate latitude by observing the meridian altitudes of stars nearer the horizon.

At the time of the early migrations, that is between 3,000 and 6,000 years ago by my father's reckoning, Polaris was not in fact the pole star of the northern heavens. Throughout that period another second magnitude star, Kochab, was nearer to the north celestial pole, attaining a declination of 84°N about 1,300 B.C., when the declination of Polaris was only 72°N.

But what seems even more interesting is that just over 5,000 years ago there was a very much brighter star than either Polaris or Kochab close to the *southern* celestial pole. This was Achernar (α Eridani) with a magnitude of 0·6, i.e. more than three times as bright as Polaris (Mag. 2·1). It reached its greatest declination of

1 See Captain Brett Hilder, 'Polynesian Navigational Stones' in the *Journal of the Institute of Navigation*, 12, p. 90, 1959.

81°S about 3,300 B.C., and no star of anywhere near that brilliance has been close to either celestial pole, north or south, from then until now—or indeed at any time during the past 12,000 years.

It may well have been part of a Gilbertese navigator's training to learn the meridian altitudes of Achernar, above or below the pole, for different known islands, and also for one or two mythical or hoped-for lands far out across the Pacific. To do this he needed standards of measurement which could be compared and passed on to his descendants, just as the measurements for building canoes were handed down from generation to generation. Ancient Chinese and Arab navigators both used a finger's breadth at arm's length, which covers approximately 1½°. Gilbertese seamen may well have adopted a similar basic unit, as they did in canoe building, where the breadth of the quick (*Te-ari-ni-bai*), the breadth of the nail (*Te-uki-ni-bai*) and the middle finger's length (*Te-tabo-ni-bai*) were all standard measurements.

A remarkable voyage made recently by Dr David Lewis and his family, from Tahiti to New Zealand in the catamaran Rehu-Moana, proved the practicability of such methods beyond any doubt.[1] Throughout the whole 2,300 mile journey Dr Lewis navigated without instruments by the sun, stars, wind, swell and any random scraps of evidence that presented themselves—the behaviour of birds, the colour of the sea, unusual cross swells, seaweed, fishes and so on. Periodically he fixed his latitude by estimating a star's angular distance from the zenith as it passed overhead. At the end of the voyage he compared these latitude 'fixes' with observations made by another member of the crew with a sextant. It may be that meridian altitude observations of circumpolar stars would have been even closer. Certain it is, in any case, that by one of these methods (zenith or circumpolar star observations), perhaps even both, experienced Polynesian navigators, who had devoted many years to studying the heavens, could have kept themselves within ten or fifteen miles of a given latitude as they sailed east or west across the Pacific.

This would have been quite close enough. When viewed from these two directions, many of the islands overlap each other, forming continuous fronts between thirty and forty miles long from north to south. Marakei, Abaiang and Tarawa together account for nearly forty-five miles of latitude, with Maiana covering another twelve miles from seventeen to twenty-nine miles further south. Many other groups, especially parts of the Marshalls and Tuamotu archipelagoes, are even more closely packed. The Marshall and Gilbert islanders in particular were also adept at judging the proximity of land by certain types of cross swell which extended several miles to seaward from the shores of an island, and so effectively increased its size to an experienced navigator.

In addition, between all the islands there were the seamarks (*betia*) described in Chapter 6.

1 'An Experiment in Polynesian Navigation', *Journal of the Institute of Navigation*, April 1966. See Appendix 1.

The Dynamics of Space and Time in Hawaiian Spirituality

[An Exploration of Contemporary Spirituality: Axial and Primal Traditions"; East-West Center of Culture and Communication, Burns Hall, June 10-13, 1991]. By Rubellite K. Johnson

Explanation

This presentation takes the opportunity to provide some answers to questions posed earlier in topic suggestions for future conferences:

"Finally, I would like to mention some topics that we are considering for future workshops and conferences...One of these topics is the set of issues related to sacred sites in Asia, the Pacific, and the Americas. Such issues would include the following. Why are certain sites especially sacred? What power is associated with such sites? What buildings are appropriate at a sacred site? What is the relationship between sacred sites and the surrounding areas? In what sense is all land sacred? What is happening to sacred sites in the process of modernization?" [Letter from Steve Friesen, East-West Center Research Fellow].

Response

Sacred sites in Hawaii are those with historic and religious importance. Historic importance alone is not significant. Religious importance outweighs historic importance in ascertaining which sacred sites are more sacred than others. Mauna'ala, site of the Royal Mausoleum housing the deceased members of the royal families of two Hawaiian dynasties is a very sacred place. About a quarter mile up the same valley of Nu'uanu is Hanaiakamalama, the summer home of the late Queen Emma, now a museum. It is a precious historic landmark of the Victorian Age of the Hawaiian monarchy, but it is not as sacred as Mauna'ala, the burial place of the kings, all except one. King Lunalilo's vault in the cemetery adjacent to Kawaiaha'o Church in downtown Honolulu is very sacred. Punchbowl Hill, once a place where captured Hawaiian chiefs preferred to be sacrificed rather than at other places, is home to soldiers who fell in several wars, the world wars I and II, the Korean War, and the Vietnam War. It is doubly sacred.

It does matter, however, whether burial places hold the bones of royal personages or commoners. Burial places are always sacred where they are found. But, the older the burial, the more critical is the law in regulating how the bones are to be treated, and if they are ancient Hawaiian burials, the more complicated is the process by which developers are allowed to proceed with permits for excavation and construction. The site may not be an ancient Hawaiian burial site, inasmuch as the remains are not identifiable, but they are valuable from the archaeological point of view. Even archaeology, however, may not proceed in areas where Hawaiian skeletons and burials are discovered since recent laws are as strict upon archaeologists to proceed with study of ancient bones and archaeological sites as on real estate developers.

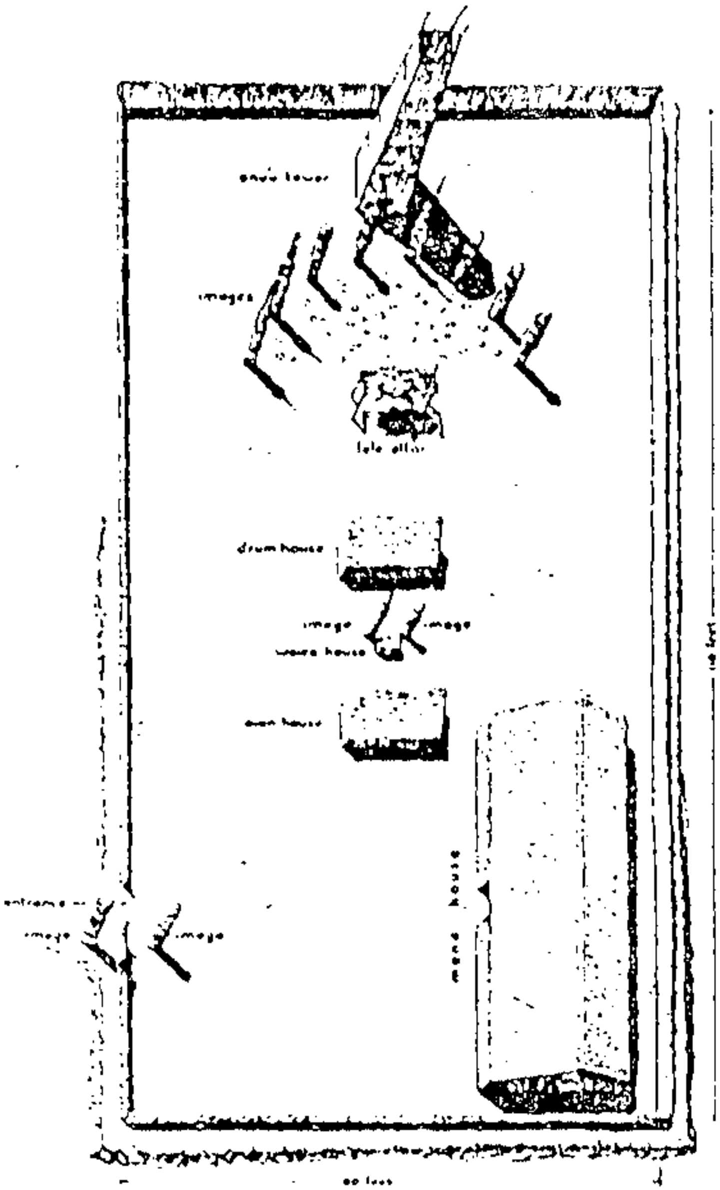
Equally valued among ancient Hawaiian sites are the stone temples, called heiau, although some are perhaps more sacred than others, depending upon their function and the rank of the deity for whom they were built, as gods were ranked in importance in hierarchical order as were chiefs. Ku, god of war and construction, was highest in rank among the four gods of the pantheon. Then Lono, god of peace and agriculture, followed by Kane, god of atmosphere and creation, then Kanaloa, god of the sea. There were only two priesthood orders, one for the god Ku and the other for the god Lono. There were no priesthood orders for Kane and Kanaloa. The priesthood orders were connected with the construction and consecration ceremonial rites of the temples honoring Ku and Lono, so that heiaus of the luakini class (walled and terraced stone temples) were more sacred and more elaborately constructed than others. [Luakini comes from lua, meaning 'pit', and kini, meaning 'many'].

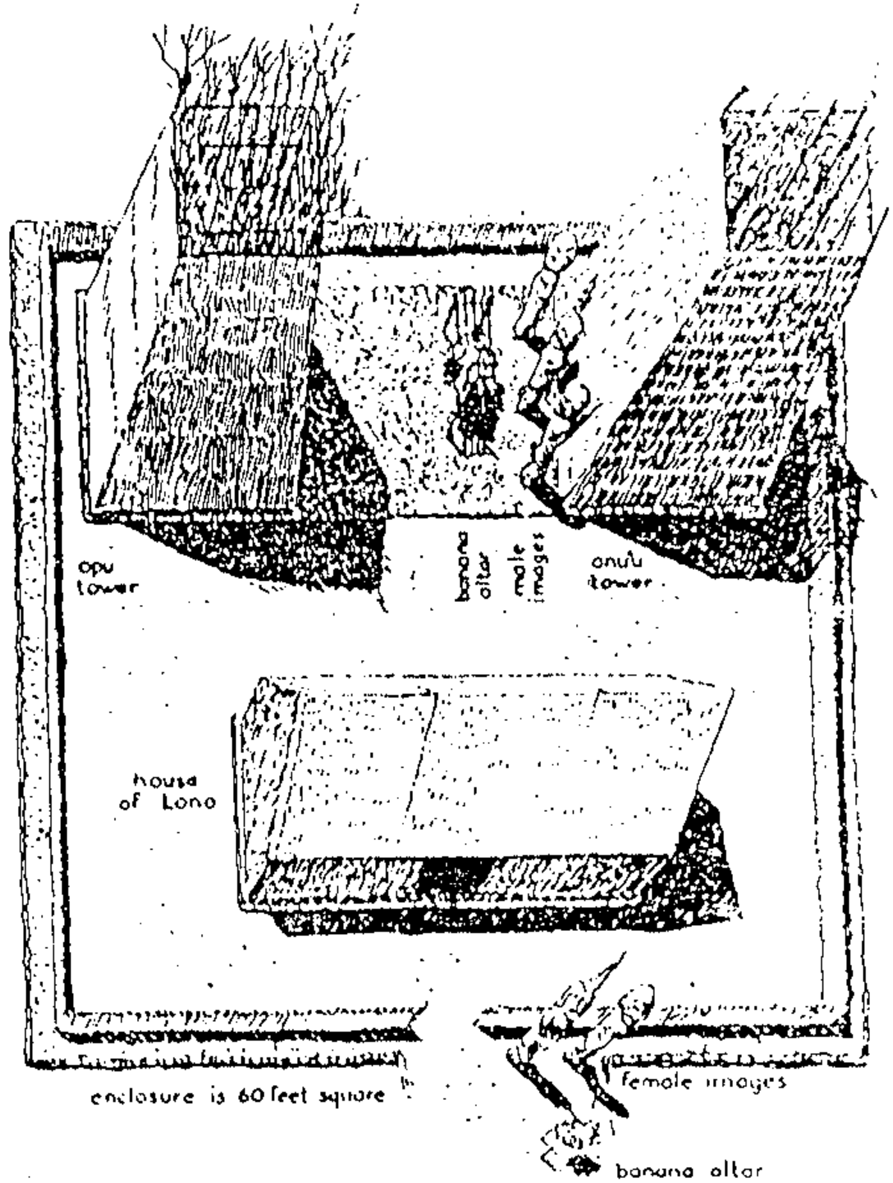
Of the luakini class heiau, the heiau po'okanaka [po'o, 'head, skull'; kanaka, 'man'] was the most sacred temple dedicated to the war god Ku, also called a wai kaua heiau (war temple). It took its name from human skulls fixed to the main posts of the sacred lama fence surrounding the sacred area. Next in importance was the heiau ho'oulu 'ai [ho'oulu, 'to increase'; 'ai 'food'], also called mapele, dedicated to Lono, god of agriculture and peace. The pu'uhonua [pu'u 'hill'; honua, 'placenta', as of Earth Mother], such as the City of Refuge in Honaunau, Kona, Hawaii, a place for absolution, pardon, mercy, amnesty, and clemency, for restoring criminals to society free of the death penalty, was also a Lono type temple.

[See illustration, page 2a for (a) luakini class, heiau po'okanaka, heiau Ku type, with one oracle tower (anu'u); (b) luakini class, heiau ho'oulu 'ai/mapele, heiau Lono type, with two oracle towers (anu'u and opu)].

The luakini class heiaus dedicated to Ku and Lono, requiring the institutionalized priesthood orders for these gods, were more important than other heiau because they were established on a national, or wider community basis, than immediate or extended family worship. They were built to accommodate the formal worship rituals for larger districts or the entire island representation.

Of lesser grade were the unu and ko'a shrines, one a coastal type [ko'a kai] dedicated to Ku'ula-kai [Ku-of-ocean-abundance] as god of fishermen, and another type upland [ko'a uka] dedicated to Ku'ula-ula [Ku-of-upland-abundance] as god of farmers. Ku'ula-kai of the coastal ko'a kai shrine [ko'a 'coral] was a carved stone image, usually a fish form, to which the first fish of the daily catch was offered. Daily rituals for Ku-of-the-upland [Ku'ula-uka] were vegetable offerings. Ku was the patron deity of fishermen and farmers, while Lono was the god of rain, thus of agriculture and the agricultural year, the annual harvest time for tax-collecting. Ku was invoked on a daily basis by fishermen





[Drawings by Paul Rockwood, in John Papa Ii, Fragments of Hawaiian History, 1959: 34,37; Bishop Museum Press] and farmers because their wooden tools were made from hard woods that were the kinolau [kino 'body'; lau 'many'], or physical manifestations of the god in the shape, hardness, and power (mana) of woods, i.e., the mana of the woods and the increased mana of tools manufactured by intelligent beings.

The sacredness of a place is therefore determined by the presence of two things:

(a) mana, or power, manifested in nature from a superordinary source, as of the gods (akua) and of the spirit ('uhane); and

(b) kapu, law of restriction so as to set aside a place where mana resides, as within the sacred temple area.

Since mana is a residual force which, whether from use or from contamination, is diminished, the aim of worship and ritual, with sacrificial offerings of food or other items, is to maintain the inflow and to check unnecessary outflow of mana as the power that runs the world. Ancient Hawaiian religious worship was called "ho'omana", that is, "to cause power". The temples were built to bring the gods (akua) and their power (mana) down to earth within the comfortable reach of man and society, where the conduit of power was kept open by communication with and propitiation of the gods. Mana is thus seen as having negative and positive attributes, since power is positive in the service and security it provides, but negative in the restrictive nature of the kapu system of regulation. Breaking the law of the kapu was the source of much anguish in ancient Hawaii as it prescribed capital punishment as the only remedy for violation of the sacred laws. The sacredness of ancient Hawaiian places and religious sites is therefore due to a combination of residual mana and to the restrictions of the kapu enacted in ancient times to prevent unholy entry and improper use. Sanctuaries come under the protection of kapu because of mana, as do things and people with mana.

When the eating kapu ['ai kapu] was overthrown in 1819, by Kamehameha II [Liholiho] and the queens, Keopuolani and Ka'ahumanu, the unu o Lono [unu, a shrine], also known as the Ipu (gourd) o Lono, the sacred gourd image in the hale mua (men's eating house),was no longer needed as a sacred shrine for the required daily religious rites of the 'alana sacrifice performed by men. The heiaus were also closed after the abolition of the kapu system, as they also were no longer required. Hewahewa, the high priest, had officially renounced his sacred office of the kahuna nui, and by doing so had also effectively abolished the ordained priesthoods of the temples for Ku and Lono. This did not remove the gods themselves as they continued to be worshipped on the informal family and occupational levels of the society. The quasi-judicial function of the heiau Ku, however, as a place to carry out capital punishment adjudicated by the chiefs against criminal lawbreakers through human sacrifice came to an end. So also the reciprocal commuting of death sentenees as the prerogative of the Lono priesthood on the heiau pu'uhonua "cities of refuge", where the condemned were returned to society after purification in a second rebirth through the placenta (honua 'earth', 'placenta') of Earth Mother [Papa-hanau-moku, 'Stratum-rock-giving-birth-to-lands']. Human sacrifice as execution of criminals in the society was associated with patriarchal law; clemency with matriarchal mercy.

In 1820 American missionaries arrived, into this vacuum of theocracy, with high aspirations to convert the native Hawaiian population to Christianity. Since the formal structure of Hawaiian religion was then non-existent, its temples vacant and ritual schedule unenforced, the missionaries met with little resistance. On the whole Hawaiians embraced the new religion. For the most part, however, ancient beliefs continued in healing practices and family worship in the home. The national, formal patterns of religious ritual associated with the heiaus and priests [kahuna], however, ceased to be important except as part of the indigenous past.

As generations passed, the formal patterns of religious ritual on the heiau became too remote for the memory of native Hawaiians to recall. Ritual prayer chants [pule] lost their original sacred meanings until they could no longer be recaptured by later generations such as ours. Suddenly it seems to be sacrilege that this has happened, and we are supposed to recover all of what has passed beyond our comprehension as though we must still understand perfectly and completely what our ancestors once said and did that was part of an irreplaceable heritage. How is this possible, when the Hawaiian priesthood were esoteric orders, given to secret strategies? How are we to penetrate the breach between us now? It seems that only by the tools of historical analysis can this broken past be reconstructed, if only to understand how it functioned and what it achieved that was of benefit to ancient society.

The history of Hawaiian ritual, however fragmented in the written and translated record which remains for us today, may to some extent help us to recover something of that past. Writings of the Hawaiian scholars, David Malo, Samuel Kamakau, John Papa I and Kepelino shed some light on the heiau as a place of worship. The combined record of the ritual schedule gives some idea of how sacred space was determined and how efficacy of ceremony was effected. An important element seems to be the relationship between sky and earth, between human life and cosmic creation, between the cycles of cosmic time and life on earth. The temple, as hale o ke akua, or 'house of god(s)', seems in its architecture to have been an attempt to center the birthplace of man and his homeland where it would meet, ascend to, or descend from the center of the universe. This center, or piko o ka honua, 'navel-of-Earth-Mother', is the terrestrial equator which extended along the line of a great circle, ke ala i ka piko o Wakea, 'the-path-to-the-navel-of-Sky-Father', or the celestial equator. To find one's own center, he should lie with his navel pointing skyward, or stand with the center [manawa, piko] of his head beneath the zenith sun at noon [awakea]. At night he should lie in the same place, preferably around midnight, or when a star or star cluster is in the zenith. Then, find Hōkūpa'a (Polaris) in the north and align it with the apex of the upright Southern Cross [Kape'a] before it declines. The line drawn overhead between north and south through the zenith axis of your locus [piko] defines your meridian (longitude) and local time. This imaginary line was called the kaupoku (ridgepole) of the "house of god" [ka hale o ke akua], the "house" being the heiau. Space is empty except for moving celestial lights. The diagram of the house served as an outline against the emptiness through which the movement of these celestial bodies could be tracked at night.

The simplest way to understand the correlation between sacred space and cosmic time is to start with time, because we understand the rhythm of time more easily than we are able to position ourselves on earth. If we are out of range, for example, of familar surroundings, dislocated, we are unable to find home. How do we proceed into unfamiliar territory without maps or charts?

None of us has difficulty relating to night and day as the first rhythm of infant time, since our conditioning is from night to day, between the oscillations of moon and sun, between darkness and light, sleeping and waking. This is the beginning of sight and the understanding of death as the limit of life and time, a most primitive cognition. This cycle is built into our consciousness and unconsciousness, into our most elementary perceptions of space and time. When we begin to abstract the concept of linear time, we comprehend our mortality. We may also not realize how fundamentally our religious beliefs are conditioned by these oscillations. They are the very basis of ritual expression in the relative dimensions of structured space and time within the limitations of earth-bound existence and the limitless expansion of the cosmos into infinity.

The ancient Hawaiian ritual calendar was, therefore, a canonical imperative of the priesthood to adjust the timing of ritual ceremony so that its efficacy was assured. This responsibility was given to the Lono priesthood.

The god who had charge of annual time was Lono-i-ka-makahiki, 'Lono-in-the-year'. The makahiki was the Hawaiian agricultural year, which was coordinated between the moon and the star cluster of the Pleiades in Taurus. The priests waited for the first new moon after the first evening rise of the Pleiades after autumn equinox to start counting the new year. That event happens about November 20th.

The standard makahiki year in the general calendar had twelve months:

1. Ikuwā	October-November	
2. Welehu	November-December	Antares [Scorpius]?
3. Makali'i	December-January	Pleiades [Taurus]
4. Ka'elo	January-February	Mercury (?)
5. Kaulua	February-March	Sirius [Canis major]?
6. Nana	March-April	Gemini (?)
7. Welo	April-May	(?)
8. Ikiiki	May-June	Regulus [Leo]
9. Ka'aona	June-July	(?)
10. Hinaía'ele'ele Hilinehu	July-August	(?)
11. Mahoe-mua	August-September	Castor [Gemini]
12. Mahoe-hope	September-October	Pollux [Gemini]

[*Note: the assignment of star identifications to the above month names are only possiblities; where there are no question marks the identifications are sure].

The makahiki was also a four-month "first-fruits" festival season for tax-collecting within the annual makahiki year. This makahiki festival was a 120-day period, or four months, during which attendance required of males at heiau temple services was suspended.

Makahiki Season (four months): Lono ritual (first fruits):

Ikuwa [Hawaiian year began]	October-November	Makali'i (rising/after sunset

1000 A.D. Makali'i rising September/October
2000 B.C. Makali'i [Pleiades in Taurus] replaced by Aries at the vernal equinox
1 A.D. First Point in Aries now in Pisces
2000 A.D. First Point will be in Aquarius

Welehu	November-December	Antares in Scorpius [winter solstice/December 21]
Makali'i	December-January [Makali'i culminates]	

[Tropic of Capricorn = sun at 23.5 degrees = Ke ala polohiwa a Kanaloa]

Ka'elo [End of makahiki season]	January-February	Mercury/Baachus (in Tahiti)

This four-month freedom [noa] from required attendance at the heiau was called 'noa', meaning 'free' in the sense of being free from kapu. During the other eight months of the year the kapu periods, called pule (prayer) were in effect during each month. The pule were prayer periods set aside for required recital; there were four pule periods in each month. They added up to nine nights (or days) per month, called na lā kapu kauila or "kauila nights". (The Hawaiians reckoned "days" [la] by "nights" [po]. During eight months when these pule periods were in effect, there were 72 kapu kauila nights in all when the male members of the society were required to be in temple attendance, and when all labor in fishing and farming was set aside. These kapu kauila days were ritualized into cyclical lunar time and consecreted by the kapu system.

Cyclical lunar time was the basis for setting the pule periods into ritual order. The Hawaiians had thirty nights/days in each month, called mahina or malama for the moon, personified as the goddess Hina (symbolizing cardinal direction west), who ruled over ocean tides and reef life. The nights were thus counted into three ten-day weeks called anahulu, meaning 'a measure of ten':

1. Hilo [Mercury, Procyon]	11. Huna	21. Olekukahi
2. Hoaka	12. Mohalu [Shaula]	22. Olekulua [3rd q.]
3. Kukahi	13. Hua [Jupiter]	23. Olepau
4. Kulua	14. Akua	24. Kaloakukahi
5. Kukolu	15. Hōkū [full moon]	25. Kaloakulua
6. Kupau	16. Mahealani	26. Kaloapau
7. Olekukahi [1st quarter]	17. Kulu	27. Kane
8. Olekulua	18. La'aukukahi	28. Lono
9. Olekukolu	19. La'aukulua	29. Mauli
10. Olepau	20. La'aupau	30. Muku [new moon]

The pule periods were assigned to three gods from the pantheon [Ku, Kanaloa, and Kana] and to Hua (the identity of which is unknown, except that Hua is one of Jupiter's names), as follows:

1. The Ku tabu was set on the evening of Hilo, the first crescent moon after the dark phase [Muku], and lifted on the morning of Kulua = 3 days.

2. The Hua tabu: set on the evening of Mohalu and raised on the morning of Akua = 2 days.

3. The Kanaloa tabu: set on the evening of Olepau and raised on the morning of Kaloakulua = 2 days.

4. The Kane tabu: set on the evening of Kane and raised on the morning of Mauli = 2 days.

By this arrangement the Ku tabu period totalled 24 days in the year; each of the others, Hua, Kanaloa, and Kane 16 days each, for a combined total of 72 kapu kauila worship days in the heiau.

STRUCTURE OF HAWAIIAN LUNAR MONTH

			KAPU KAUILA NIGHTS (SACRED NIGHTS)	PULE PERIODS (TABU PERIODS)
1 ◐	.5	MUKU	'CUT-OFF'	NEW MOON/ LAST NIGHT OF PREVIOUS MONTH = 1/2 DAY
2 ◐	1	HILO	'TWISTED CORD'	WAXING MOON/FIRST CRESCENT WEST, SETTING AT SUNSET.
3	2	HOAKA	'CRESCENT, 'EMBRYO' 'CAUSE SHADOW', 'OPEN MOUTH	SETTING AT SUNSET RISING AT SUNRISE
4	3	KŪKAHI	'KŪ-ONE' 'PIERCE'	(KŪ, GOD OF EAST) ALSO GOD OF WAR, FISHING, CARPENTRY
5	4	KŪLUA	'KŪ-2'	MOON RISING AFTER DARK
				(SACRED DAYS, TEMPLE DUTY: 3 DAYS, IMPOSED ON THE NIGHT OF HILO AND LIFTED ON MORNING OF KULUA, CALLED 'TABU OF KŪ').
6	5	KŪKOLU	'KŪ-3	
7	6	KŪPAU	'KŪ-FINISHED'	
FIRST QUARTER				
WAXING GIBBOUS				
8 ◐	7	OLEKUKAHI	'NOT-PIERCE-1', 'FIRST-TOOTH/FANG'	MOON IN THE SOUTH AT SUNSET. FIRST QUARTER, TERMINATOR STRAIGHT, FORMS EQUAL HALVES; LIGHTED HALF FACING WEST; EVENING TO MORNING WINTER MON[TH] HIGH SURF; FALL, LOW TIDE EVENING TO MORNING.
9	8	OLEKULUA	'NEGATIVE-2'	
10	9	OLEKUKOLU	'NEGATIVE-3'	
11	10	OLEPAU	'NEGATIVE-FINISHED'	END OF FIRST TEN-DAY WEEK, ANAHULU = 'MEASURE 10'

STRUCTURE OF HAWAIIAN LUNAR MONTH (CONTINUED)

ROUNDING MOON

12	11	HUNA	'HIDDEN'	NO CRESCENT, HORNS HIDDEN
13	12	MOHALU	'CLEARNESS, QUIET'	HUA TABU (SACRED DAYS, TEMPLE DUTY; 2 DAYS, IMPOSED ON NIGHT OF MOHALU, LIFTED ON THE MORNING OF AKUA).
14	13	HUA	'EGG-SHAPED'	TERMINATOR ON EDGE; APPROACHING FULL MOON
15 ○	14	AKUA	'GOD'	FULL MOON, MOON EAST (HALF SYNODIC MONTH) (ONE FORTNIGHT) RISING AT SUNSET
16	15	HOKU	'STAR'	
		HOKU PALEMO	'SINKING STAR'	MOON SETS BEFORE DAYLIGHT
		HOKU ILI	'STRANDED STAR'	MOON IS ABOVE HORIZON AFTER SUNRISE; SETS AFTER SUNRISE
17	16	MAHEALANI	HOKU ILI (STRANDED) SETS AFTER SUNRISE	
18	17	KULU	'DROP'	(THIN CRESCENT, WANING GIBBOUS MOON)
19	18	LA'AUKUKAHI	'PLANT/POST-1'	MOON APPEARS AFTER DARK, LIGHT SIDE OF CRESCENT TURNEI EAST, TOWARD SUNRISE
20	19	LA'AUKUKAHI	'PLANT-2'	
21	20	LA'AUPAU	'PLANT-FINISHED'	

END SECOND 10-DAY ANAHULU WEE

STRUCTURE OF HAWAIIAN LUNAR MONTH (CONTINUED)

22	21	OLEKUKAHI (TERMINATOR LINE IS STRAIGHT; EQUAL HALVES)	'NEGATIVE-1'	THIRD QUARTER MOON. MOON IN SOUTH AT SUNRISE RISES AT MIDNIGHT, HIGH IN SKY AT SUNRISE
23	22	OLEKULUA	'NEGATIVE-2'	
24	23	OLEPAU	'NEGATIVE-3' WANING CRESCENT	CRESCENT VISIBLE BEFORE SUNR KANALOA (KALOA) TABU (GOD OF THE SEA, REGULATES TIDES, FI ING; SACRED DAYS, TEMPLE DUT IMPOSED ON THE NIGHT OF OLEP LIFTED ON MORNING OF KALOAK 2 DAYS.
25	24	KALOAKUKAHI	'KANALOA-1'	
26	25	KALOAKULUA	'KANALOA-2'	
27	26	KALOAPAU	'KANALOA-3'	
28	27	KANE	'GOD', OF SUNLIGHT, STARS, TROPIC OF CANCER, MILKY WAY, WATER	CRESCENT MOON RISES AT DAWN KANE TABU, IMPOSED AT NIG OF KANE, LIFTED MORNING O MAULI, 2 DAYS.
29	28	LONO	GOD OF YEAR, MAKAHIKI FESTIVAL, MOON; STAR SIRIUS; AGRICULTURE	CRESCENT MOON RISING AS DAWN BREAKS
30	29	MAULI	'FAINT, AS MOON; SPIRIT,'	THINNING CRESCENT MOON RISING AT DAYLIGHT
31	29.5	MUKU	'CUT-OFF'	MOON RISING AFTER DAYLIGHT; REJUVENATES IN THE MILKY WA WHERE THE WAI OLA A KANE RESTORES LIFE AND YOUTH

END THIRD 10-DAY ANAHULU WEEK

The progress of the moon from Muku at new moon to Hōkū at full moon in fifteen days describes a compass circuit by the revolution of the moon around the earth from west to east. It rises in the east, but when the moon is seen at first crescent it is already setting after the sun, so it is seen in the west. The moon goddess Hina is thus associated with cardinal direction west; Ku is cardinal direction east, where the sun as the kinolau form of the god Kane [Kane-'onohi-o-ka-lā, 'Kane-eyeball-of-the-sun'] rises. Kane is associated with cardinal direction north [Ke-ala-polohiwa-a-Kāne, Tropic of Cancer, i.e., summer solstice], Kanaloa, south [Ke-ala-polohiwa-a-Kanaloa, Tropic of Capricorn, i.e., winter solstice]. Kanaloa is the octopus god of the wind compass [Ipu-makani-a-La'amaomao] and symbolizes the divisions of the compass along the tentacle radials. Lono is personified as the god of annual time, and in the night sky is the star Sirius, which ancient Hawaiians used as the zenith star over Tahiti. Kane and Kanaloa are also associated with the solstice limits of the sun (as above).

The moon moves from west to east around the horizon about 12 degrees per day. At Muku (new moon) dark phase, it is directly west but cannot be seen; full moon Hoku is directly east, and the Ole moons, waxing and waning, are first and third quarter moons, south and north, respectively. This revolution is a primitive lunar compass, useful to man for lack of anything else to discern where he might be at night on the desert or at sea. In this sense, the cyclical turn of the moon measures position around the circuit, and in this sense cosmic space is defined by the movement of the moon, that is, by cyclical lunar time.

[See next three pages for lunar calendar tabu periods].

The Ku tabu was imposed on the first four nights of the waxing crescent moon [Hilo to Kulua]. The moon moved south of west, coordinated with Mercury, or Procyon (or both). The tabu of Hua was set during the gibbous phase two nights before full moon, coordinated probably with Jupiter, or Shaula in Scorpius (or both). The tabu of Kanaloa was set two nights after third-quarter moon, when it was west of north; the tabu of Kane two nights of the waning crescent moon before the dark phase [Muku], when the goddess Hina as the moon was believed to become a "spirit" [mauli], dying at Muku. The spirit [Mauli, 29th night of the moon] then entered the Wai Ola a Kane sacred pool of life-giving, healing waters in the Milky Way. At Hilo she revives, and a shank of her braided hair [Hilo, 'twist'] becomes visible.

Two principles of calculating lunar time can be deduced from the Hawaiian system:

Olekukahi (21st)
Portion to king's gods/kahuna/ queen/court and the 'ai alo (chiefs + military companies)
Feather gods carried in procession (evening)

Olekulua (22nd)
Wooden gods carried in procession (evening)

Olepau (23rd)
Made image of Lonomakua (ku-i-ke-pa'a work)

Lonomakua image: 10 inches circumference
2 fathoms length (12 feet)
joints carved at intervals
ke'a crosspiece with pala fern
ka'upu bird at top
white tapa cloth made of wauke
anointed with coconut oil
accompanied by akua pa'ani

Kaloakukahi (24th)
Fires lit along coast (morning)
Tabu on activity for 4 days
Hi'uwai ceremonial bathing

Makahiki tabu imposed in the morning
Akua loa and Akua poko circuits
Alia poles - akua loa stood between the alia
- alia ope'a
- ho'okupu (taxes) placed between the alia and akua loa
Hainaki prayer at the end of offerings
Image turned face down after noa (freeing) of land
Image carried face backward
Image taken back to chiefs: Hanau pu ceremony of feeding the idol (kulolo, haupia, bananas, coconuts, 'awa)/ carrier fed/ then niho-palaoa hung around the image/ griding of the god with the kaioloa tapa

Kaloakulua
Kaloapau
Sports events

Kane (27th)
Pala fern picked, signifying the freeing of cultivated fields from tabu/ keepers of the god Kane made bundles of lu'au leaves, cooked them on open fire, put them up on the sides of their houses to signify that farms were relieved from tabu

Lono (28th) Same things done by kahu of Lono
Mauli (29th) Same things done by kahu of Kanalc

[On the 27th night (Kane) the chiefs (ali'i) gatherec pala fern; lighted the Puea bonfire along the shore; canoe sent on fishing expedition; males/chiefs ate of the catch (on the night of Lono, 28th)]

(1) The principle of the synodic count:

From its starting position at new moon, until it returns to that point, the moon revolves around the earth once every 29.5 days;

(2) The principle of the sidereal count:

With respect to a star on the meridian, the moon's period of revolution around the earth is 27.3 days (Kane is the 27th night in the Hawaiian moon calendar).

Therefore:

The earth and moon revolve around the sun, so that in one month, for every sidereal revolution of the moon around the earth in 27.3 days, the earth moves 1/13 of its orbit around the sun.

[*Note: the above is stated as though the Hawaiian priests understood that the sun is at the center of the solar system, but they may not have known that. The sun, in their system, may have been perceived as moving around the earth, with the earth at the center of the solar system. However, the numerical count does not alter in either case].

No.months		Fortnights (Kane)	Sidereal	Synodic/remainder		
	(Hua)	13.5				
1	(Kane)	13.5	27	+ 3	=	30
	(Hua)	13.5				
2	(Kane)	13.5	27	+ 3	=	30
		4 fortnights	54	+ 6	=	60 days
	(Hua)	13.5				
3	(Kane)	13.5	27	+ 3	=	30 days
	(Hua)	13.5				
4	(Kane)	13.5	27	+ 3	=	30 days
		8 fortnights	108	+ 12	=	120 days
	(Hua)	13.5				
5	(Kane)	13.5	27	+ 3	=	30
	(Hua)	13.5				
6	(Kane)	13.5	27	+ 3	=	30
		12 fortnights	162	+ 18	=	180 days

No. months		Fortnights (Kane)	Sidereal		Synodic/remainder		
	(Hua)	13.5					
7	(Kane)	13.5	27	+	3	=	30
	(Hua)	13.5					
8	(Kane)	13.5	27	+	3	=	30
		16 fortnights	216	+	24	=	240 days
	(Hua)	13.5					
9	(Kane)	13.5	27	+	3	=	30
	(Hua)	13.5					
10	(Kane)	13.5	27	+	3	=	30
		20 fortnights	270	+	30	=	300 days
	(Hua)	13.5					
11	(Kane)	13.5	27	+	3	=	30
	(Hua)	13.5					
12	(Kane)	13.5	27	+	3	=	30
		24 fortnights	324	+	36	=	360 days
	[*<u>makahiki:</u> intercalate			+	5	=	365 days]
	(Hua)	13.5					
13	(Kane)	13.5	27	+	3	=	30
		26 fortnights	351	+	39	=	390 days
			[364.5	+	00.5	=	365]
	(Hua)	13.5		+	00.25	=	365.25]
14	(Kane)	13.5	27	+	3	=	30
		28 fortnights	378	+	42	=	420 days
	(Hua)	13.5					
15	(Kane)	13.5	27	+	3	=	30
	(Hua)	13.5					
16	(Kane)	13.5 fortnights	27	+	3	=	30
		32 fortnights	432	+	48	=	480 days

(etc.)

The extension of the sidereal/synodic lunar revolution beyond annual limits recalls the Indic Mahayuga "Great Age" of 432,000 eons [Von Dechend, Hetha and Giorgio Santillana, <u>Hamlet's Mill</u>, 1969: 7, 162-163]:

"...When one finds numbers like 108, or 9 x 13, reappearing under several multiples in the Vedas, in the temples of Angkor, in Babylon, in Herclitus' dark utterances, and also in the Norse Valhalla, it is not accident...

"...It is known that in the final battle of the gods, the massed legions on the side of 'order' are the dead warriors, the 'einherier' who once fell in combat on earth and who have been transferred by the Valkyries to reside with Odin in Valhalla --'Five hundred 'einherier' come out of each one gate...that makes 432,000 in all, a number of significance from of old...

"...This number must have a very ancient meaning, for it is also the number of syllables of the Rig Veda. But it goes back to the basic figure 108,000, the number of stanzas in the Rig Veda (40 syllables to a stanza), which, together with 108, occurs insistently in Indian tradition. 10,000 is also the number which has been given by Heraclitus for the duration of the Aion, according to Censorinus (De Die Natali 28), whereas Berossos made the Babylonian Great Year to last 432,000. Again, 10,800 is the number of the Indian fire-altar (Agnicayana)..."

"...To quibble away such a coincidence,' remarks Schroder, 'or to ascribe it to chance, is in my opinion to drive skepticism beyond its limits. Shall one add Angkor to the list? It has five gates, and to each of them leads a road, bridging over that water ditch which surrounds the whole place. Each of these roads is bordered by a row of huge stone figures, 108 per avenue, 54 on each side, altogether 540 statues of Deva and Asura, and each row carries a hug Naga serpent with nine heads. Only, they do not 'carry' that serpent, they are show to 'pull' it, which indicates that these 540 statues are churning the Milky Ocean, represented (poorly, indeed) by the water ditch, using Mount Mandara as a churning staff, and Vasuki, the prince of the Nagas, as their drilling rope' [Dechend/Santillana, 1969: 162-163].

This was noted by Joseph Campbell in a chapter on the Indic calendar round in his book [The Mythic Image,1984: 143]:

"Translating, now, the divine into human years, we arrive at the following sums:

4,800 x 360	=	1,728,000	human years
3,600 x 360	=	1,296,000	" "
2,400 x 360	=	864,000	" "
1,200 x 360	=	432,000	" "

"Furthermore:

"1,000 Mahayugas = 1 daytime (or 1 night) of Brahma (1 kalpa), i.e., 12,000,000 divine years or 4,320,000,000 human years..."

The effort of the Hawaiian priests to harmonize ritual time with cosmic time may be deduced from the annual ritual calendar when building of a new heiau, especially the heiau Ku, took place in the midst of the eight-month ordinary pule periods. The centering of the heiau so as to find the exact point which extends from one's position on earth along the extension of a great circle to the center of the universe (or the celestial equator) was a geometric problem to link the "navel" [piko] center of one's birthplace to the center [piko] of the universe (as Sky Father, Wakea). How was the "navel" [piko] center determined?

It was found by taking a cord and using it to find the radius of the heiau compass circle. This cord, the 'aha hele honua ('rope-go-the-earth') was used to square the corners of the sacred houses on the heiau. The cord was ritually "stretched" in a ceremony performed by the king and the high priest to the dimensions of a sacred house [hale wai'ea, literally, 'house-water-rising-(of-celestial-bodies)'] a cubit [ha'ilima, about 18 inches] wide by a cubit deep by two cubits long (i.e., 18" x 18" x 36"]. How this cubit length was determined is not known.

Analysis of the tabu nights of the moon, relative to major and minor moonrise and moonset positions north and south, which is a 19-year cycle, gives the following interesting results:

(1) Moon's major swing: NW 302° Kane moon (27th night), maximum northerly moonset, summer; Kane tabu, 1st night

SW 238° Kukahi moon (3rd night, waxing moon), maximum southerly moonset, winter; Ku tabu, 3rd night

NE 062° Kulu moon (17th night, waning moon), maximum northerly moon rise, summer

SE 122° Mohalu moon (12th night, gibbous moon), maximum southerly moonrise, winter; Hua tabu, 1st night.

(2) Moon's minor swing: NW 290° Lono moon (28th night, waxing moon), minimum northerly moonset; Kane tabu, 2nd night.

SW 250° Hilo moon (1st night, waxing moon), minimum southerly moonset, winter; Ku tabu, 1st night

NE 070° Mahelani moon (16th night, full moon), minimum northerly moonrise, summer

SE 110° Hua moon (13th night, gibbous moon), minimum southerly moonrise; Hua tabu, 2nd night

We may plot the moon swings thusly, for easier comprehension:

SW	250°	Hilo (Ku tabu):	minimum southerly moonset, winter
SW	238°	Kukahi (Ku tabu):	maximum northerly moonset, winter
SE	122°	Mohalu (Hua tabu):	maximum southerly moonrise, winter
SE	110°	Hua (Hua tabu):	minimum southerly moonrise, winter
NE	070°	Mahealani:	minimum northerly moonrise, summer
NE	062°	Kulu:	maximum northerly moonrise, summer
NW	302°	Kane (Kane tabu):	maximum northerly moonset, summer
NW	290°	Lono (Kane tabu):	minimum northerly moonset, summer

It is only by doing this kind of tedious analysis that descriptions of heiau ritual given by native Hawaiian writers more than a century ago may be faithfully interpreted.

The dynamics of celestial motion and structure in space as cosmic time seems to have been a passion of the priests in metaphysical theology, in an attempt to understand the structure of the universe from which man to life, as their ritual articulation about the creation tries to penetrate its effects by trying to comprehend causes. The ritual prayer to invest the chief at birth is an aesthetic example of their ability to reason thus:

O ke au i kahuli, wela ka honua
O ke au i kahuli, lole ka lani
O ke au i kuka'iaka ka la,
E ho'omalamalama i ka malama

O ke au o Makali'i ka po
O ka walewale ho'okumu honua ia

O ke kumu o ka lipo i lipo ai
O ke kumu o ka po i po ai

O ka lipolipo, o ka lipolipo
O ka lipo o ka la
O ka lipo o ka po

Po wale ho'i

When space turned around the earth heated
When space turned over, the sky reversed
When the sun appeared standing in shadows
To cause the light to make bright the moon,

When the Pleiades are small eyes in the night,

From the source in the slime was the earth formed
From the source in the dark was darkness formed
From the source in the night was night formed

From the depths of the darkness, darkness so deep
Darkness of day, darkness of night

Of night alone
Did night give birth

Born was Kumulipo in the night, a male
Born was Po'ele in the night, a female

Hanau ka po
Hanau Kumulipo i ke po, he kane
Hanau Po'ele i ka po, he wahine

O piha, o pihapiha
O piha u, o piha a
O piha e, o piha o

O ke ko'o honua pa'a ka lani
O lewa ke au, ia Kumulipo ka po
Po no.

Filling, filling full
Filling, filling out
Filling, filling up

Until the earth is a brace holding firm the sky
When space lifts through time in the night of Kumulipo
It is yet night.

The lines of poetry above are from the Hawaiian creation chant, in which none of the gods are involved in creating but are themselves born from the universe when the light of the sun breaks forth at the birth of mankind. They reflect an inclination of native Hawaiian religious thought toward scientific reasoning about the origins of life, the relationship between inanimate and animate forms as states of material being, and the relationship between metaphysics and physics. Perhaps this is the difference between the ancient Hawaiian religious thought and today's neoclassical cultural revival. The Hawaiian priests were practicing a kind of metaphysical religion. Today's efforts are more concerned with the political effects of religious activity.

Presented in following is a summarized ritual schedule for the Ku and Lono [makahiki festival] seasons. The Ku ritual schedule was appointed for observation only when a war temple was newly built and reconsecrated, whereas the Lono [makahiki] ritual season was an annual regulation.

The Hawaiian new year began during the second month of the *makahiki* season, sacred to Lono:

Reconstructed Ritual Schedule [makahiki]:

Ikuwā	October-November	Makali'i [Pleiades rising/sunset]
	September 21st	Autumn equinox
	[1000 A.D. Makali'i rising in September/October]	
	[2000 B.C. Pleiades in Taurus replaced by Aries at vernal equinox]	
	[1 A.D. First Point in Aries now in Pisces]	
	[2000 A.D. First Point will be in Aquarius]	
Welehu	November-December	Lehua [Antares in Scorpius, *Ka Makau Nui a Maui*, 'Maui's Fishhook]
	November 21st	Hawaiian year began [first new moon (Muku/Hilo) after first evening rise of the Pleiade at sunset]
Makali'i	December-January	December 21st - winter solstice
	[Tropic of Capricorn	= Kanaloa; sun at 23.5° southern limit]
	[Makali'i culminates	90°/90 days, i.e., at zenith 20° N]
Ka'elo	January-February	Mercury/Baachus (Tahiti)
[End of Makahiki Season/First Fruits festival]		

Ku Ritual Season (conducted between the vernal equinox and summer solstice)
[allowed 10 days reconsecration/ 25 days building tabu periods]

Kaulua	February-March		Gemini/Twins Thatching of Ku heiau
	La'aukukahi	(18th)	Building of the booths/paehumu
	La'aukulua	(19th)	Carving of maka'iwa images
	La'aupau	(20th)	(continues)
	Olekukahi	(21st)	third quarter moon March 21st - vernal equinox
	Olekulua	(22nd)	(continues)
(Kaloa tabu 2)	Olepau	(23rd)	End of basic preparation
	Kaloakukahi	(24th)	Huikala rite/ purification of island at each ahupua'a
	Kaloakulua	(25th)	continues/ *alaea* ordinance
	Kaloapau	(26th)	Hawai o Papa rite (Hale o Papa)
(Kane tabu 2)	Kane	(27th)	King and priest in heiau
	Lono	(28th)	*Alaea* image and ordinance

	Mauli	(29th)	King and Priest pray in heiau
	Muku	(30th	Huikala rite for akua ka'ai/ People in 8 row/ 40-80 images
Nana	March-April		[Gemini]
	Hilo	(1st)	Tabu laid on temple/lupalupa
(Ku tabu 3)	Hoaka	(2nd)	Kauila-huluhulu (morning) Malu-ko'i (evening)
	Kukahi	(3rd)	'Oi'o (to mountains) mau ha'alelela 'Oi'o (to heiau) Nanahua post (evening) Makaiwa images (evening) Measured foundations hale mana
	Kulua	(4th)	(continues) Kauilanui service began (evening) Circuit of ka'ai/Kahoali'i rite Kai-a-pokea rite Kuwā service/ setting up images behind the Nanahua post Kapoupou'ana/ thatching of houses Hulahula service (midnight)
	Kukolu	(5th)	(maku'u tapa attached to anu'u) Ho'opi'i na aha limalima (morning) Kuili service (night)
	Kupau	(6th)	Kuili continues
	Olekukahi	(7th)	Kuili continues Kuili concluded (evening) Ho'owilimo'o service (evening) aha service at hale mana (stretching of the cord ceremony) coconut leaf girdle for haku ohi'a image 'oki ka piko rite for image maki'ilohelohe service
	Olekulua	(8th)	Ka-papa-ulua rite/ oloa tapa wrapping for the anu'u tower
	Olekukolu	(9th)	Ritual bathing in the sea
	Olepau	(10th)	Ka'i oloa service/Hale o Papa and Ku heiau/girding of Mo'i image
	Huna	(11th)	(tabu remained in effect)
	Mohalu	(12th)	Ho'omahanahana service [End 25-day building period]
(Hua tabu 2)	Hua	(13th)	
	Akua	(14th)	
	Hoku	(15th)	
	Mahealani	(16th)	
	Kulu	(17th)	[End 30-day revolution from 18th night waning moon to 17th of next]

Na lā kapu kauila = 9 tabu nights
x 8 months of ordinary tabu pule periods
72 tabu night to the year
24 tabu periods to the year
4 tabu months to the makahiki festival [Lono]

Tabu periods of the month: [4 pule periods per month]	3 Ku
	2 Hua
	2 Kanaloa
	2 Kane
	9 kapu kauila nights

Welo	April-May	
Ikiiki	May-June	End of period for consecration of Ku heiau [Kaulua, Nana, Welo, Ikiiki]; Ikiiki = Leo
Ka'aona	June-July	June 21st summer solstice Sun at 23.5 N northern limit [Tropic of Cancer = Kane]
Hinaiaeleele Hilinehu	July-August	'Opelu tabu lifted/ aku tabu began (six months alternation)
Mahoe-mua Hilinama	August-September	[Gemini; Castor] September 21st autumn equinox
Mahoe-hope	September-October	[Gemini; Pollux] End of Kau season.

Ritual calendar of the Makahiki Season [Ke au o Makali'i] [First Fruits]

Ikuwa	October-November	
Hilo + Hoaka		
Kukahi	(3rd)	Tabu days of Ku; flags flown from heiau
Kulua	(4th)	
Kukolu	(5th)	
Kupau	(6th)	
Olekukahi	(7th)	
Olekulua	(8th)	
Olekukolu	(9th)	
Olepau	(10th)	
Huna	(11th)	
Mohalu	(12th) [Shaula]	[Tabu of Hua period] 'Breaking of the king's coconut dish'/ceremony
Hua	(13th) [Jupiter]	
etc.		
Welehu [Lehua = Antares/Scorpius]	November-December	(1) makahiki taxes of the 'okana, poko, kalana land sections readied (2) levies on the loa and tribute paid from landlords (waiwai maloko)
La'aukukahi	(18th)	Taxes levied against district (cloth)
La'aukulua	(19th)	
La'aupau	(20th)	Display of taxes before the gods [ho'omoe 'ia]

Ka'elo	(January-February)	
Hilo	(1st)	Tabu of Ku imposed on Hilo and lifted on the morning of Kulua
Mohalu	(12th)	Tabu period of Hua imposed on Mohalu until morning of Akua (14th) Ho'okupu to king called the 'heap of Kuapola'(ka pu'u o Kuapola) Kahoali'i rite of plucking eye of aku and man who had been sacrificed Tabu then removed from the aku and placed over the 'opelu fish. Last day of tabu period: king + high priest accompanied by drummer ate pork/ service by a distinct set of priests (no data)
		["Now began the new year" (after Hua tabu, i.e. 13th night of Ka'elo]
Kaulua [Gemini] [Feb.-March]		Resumption of ordinary tabu days in the tabu period of Ku During Kaulua or Nana months, the king made a heiau loulu [i.e., Ku type heiau]; or mao luakini ho'ouluulu'ai [i.e., Lono type agricultural mapele type], or a luakini kaua [i.e. Ku type heiau]

The coordination between time and the geometry of sacred space is implied in the structure of the "house of god" [hale o ke akua] which is the heiau temple. This is not to suggest that all such temples were celestially aligned, except perhaps symbolically. The gourd diagram for the sidereal compass outlined by Kaneakaho'owaha [Alexander, W.D. "Instructions in Ancient Hawaiian Astronomy as Taught by Kaneakahoowaha, One of the Counsellors of Kamehameha I, According to S. M. Kamakau," Hawaiian Annual, Honolulu, 1898: 142-143] shows:

(1) the meridian between Polaris [Hōkūpa'a] and upright Crux [Southern Cross, Kape'a, Newenewe/Wenewene] which is the kaupoku (ridgepole) of the god's house (ka hale o ke akua).

(2) the ecliptic, ke ala a ke ku'uku'u (pathway of the spider), which is the sun's on the horizon between the sun's standstills at the summer solstice (23.5 N) and winter solstice (23.5° S) [drawn as a chord on the circle.

(3) the celestial equator, ke ala i ka piko o Wakea on the great circle drawn through the earth's center [ka piko o ka honua, equator] which is the track of the sun at the vernal and autumnal equinoxes (marked along the track of the Belt of Orion at 0°.

HAWAIIAN CONCEPT OF THE TROPICS, THE CELESTIAL EQUATOR, AND THE ECLIPTIC

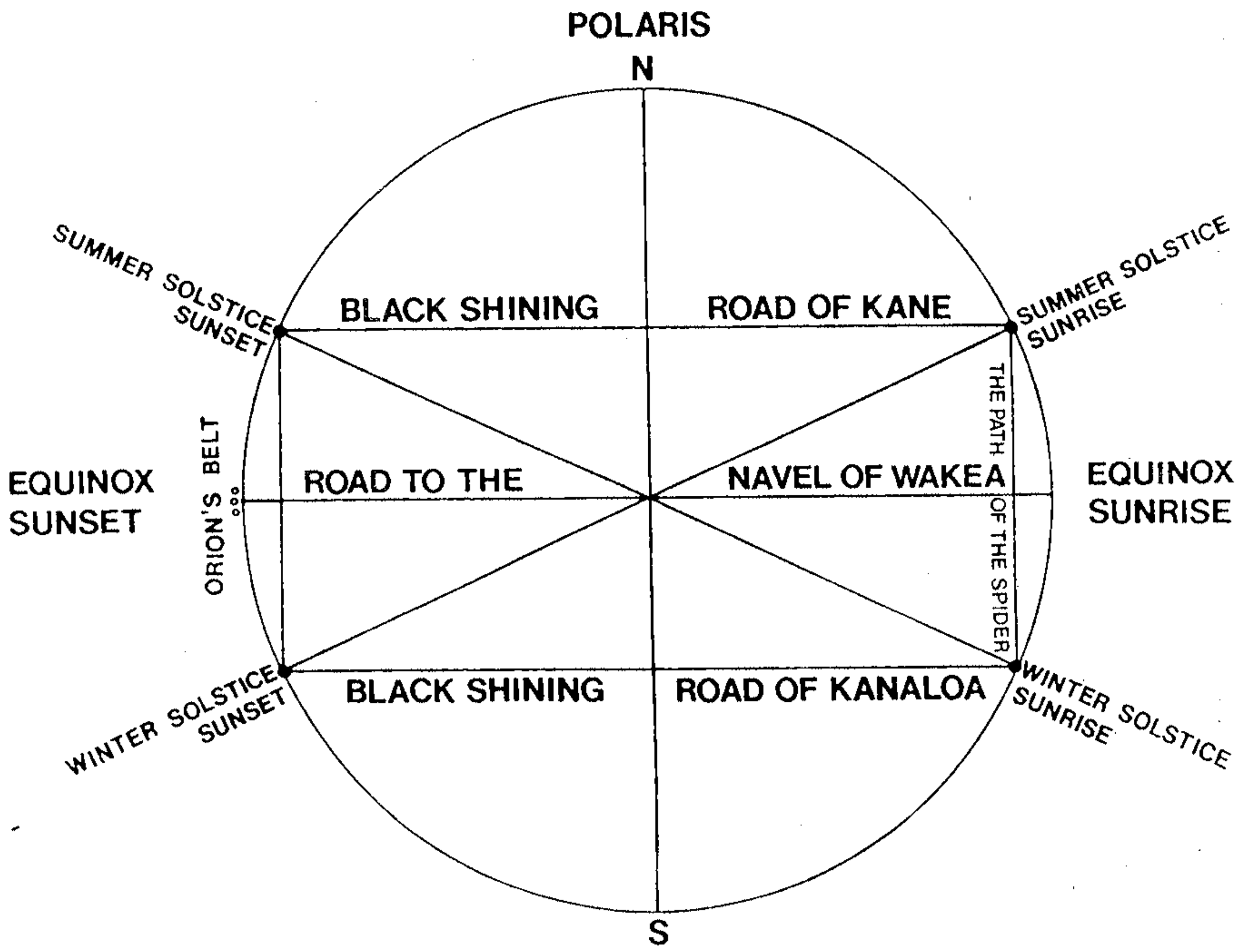


Chart by Armando da Silva

THE HAWAIIAN SYSTEM OF COSMICIZING SACRED TERRESTRIAL SPACE

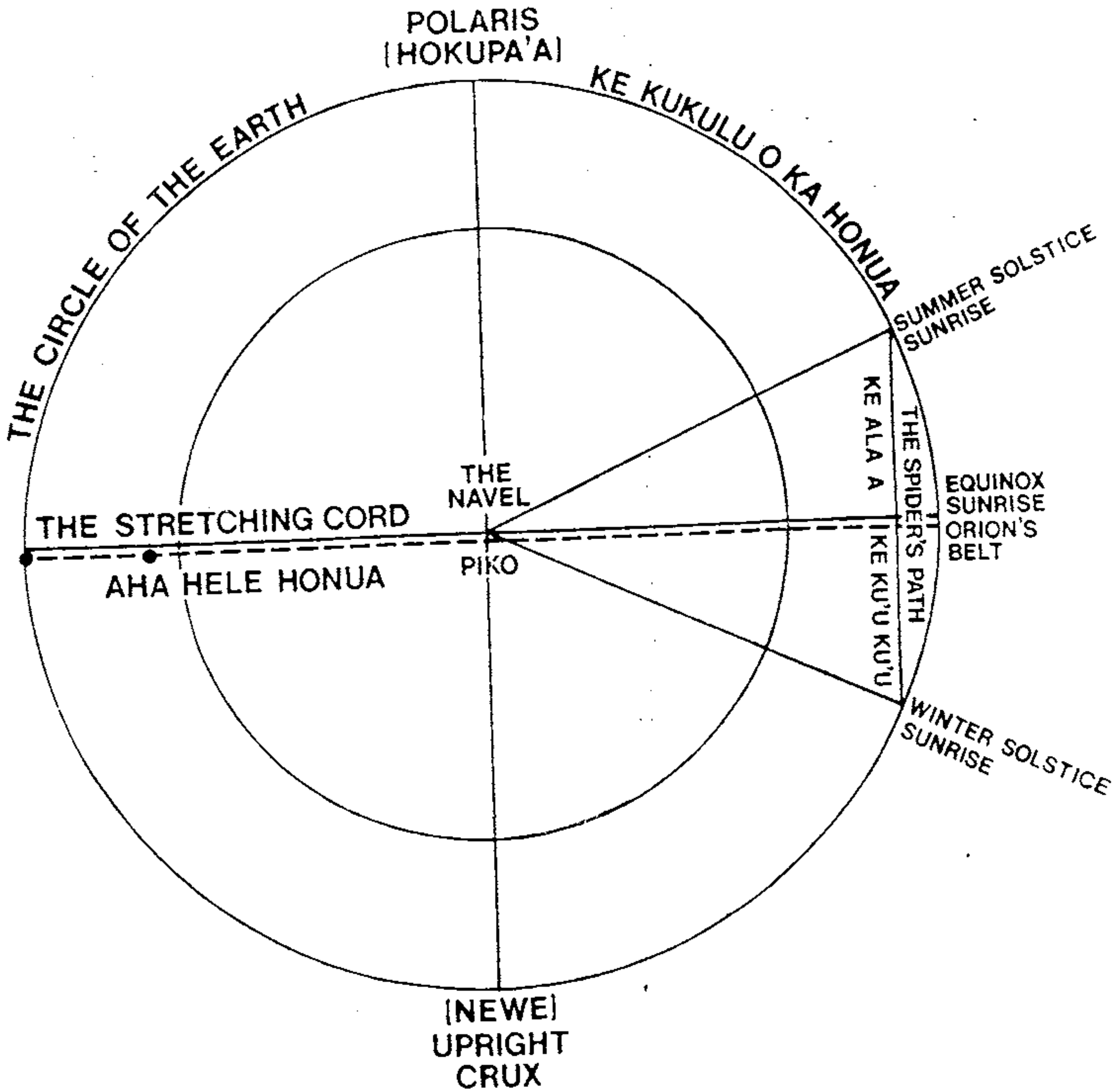


Chart by Armando da Silva

Makali'i [Pleiades]

Hilo (1st) Repeat/bonfire of Puea lit
Hoaka (2nd) Fishing canoes out to sea through Ku and Ole nights; fresh pala fern gathered; Bonfire of Puea lit until the night of Huna (11th night)/ women eat fish from the ocean in observance of kalahua

Mohalu, Hua, Akua, Hoku Tabu reinstated
Mahealani (16th) Akua loa returned (evening) Chief went out in his canoe to meeet the akua loa in the ceremony called Kali'i/mock wahie spear-throwing parried by chief

[Afternoon]: Sham spear fight [wahie] called Kanekupua/ king went into the wai'ea temple (Lono heiau), offered pig sacrifice

Kulu 17th Set up the Hale Kalama of lama wood for Kahoali'i in front of the wai'ea temple called Ka Hale Koko o Kahoali'i
Pua'a hea (red pig) put in oven with kulolo

La'aukukahi (18th) People ate from the oven/
Dismantling of makahiki images
Carriers of images fed
Kahuna closed services

Net of Maoloha ceremony (net lifted by 4 men; filled with food)
Wa'a 'auhau of Lono - Lono returning to Tahiti
Wa'a kea - canoe of unpained wood put to sea, coursed back and forth
Restrictions removed from makahiki
Orders for building new Kukoa'e heiau

La'aukulua (19th)
La'aupau (20th) King announced tabu of Kaloamakamaka service (pule) continued to Kaloakulua (25th), five days

Olekukahi (21st)
Olekulua (22nd)
Olepau (23rd)
Kaloakukahi (24th)
Kaloakulua (25th)

Kaloapau (26th) King performed purification ceremony
Built the halepu'upu'uone for himself/ the 'oe'oe booth/ covered them with pohue vine/ palima booth/ kukoa'e-ahuwai

Kane (27th) King declared tabu on all of the houses of the Kukoa'e type/ purification heiau/ King ate first pork there

Insofar as the sequence is concerned it is the same as the Ii/Malo sequence you list (Hawaii sequence), but there are important notations in Fornander's information critical to understanding how this sequence is used for different kinds of calculation.

For example why is April-May the "end of winter". We say it's the end of the rainy season, but "end of winter" is in May, Ikiiki, "when the Huhui (seven stars) sets." (See the other paper, p. 3 ff.)

This means that the month April-May (named for Welo and Ikiiki). is adjusted to the Pleiades at heliacal setting at dusk. You will find the rate at which April-May was adjusted to the heliacal setting of the Pleiades at dusk from April to May since the time when the Marquesas were settled between 100 B.C. to the present.

Then, Fornander says (Hawaiian Antiquities, Vol. 6 No. 2, p. 330-332):

"In the Hawaiian group the year was divided into two seasons, hooilo, the rainy season, from about the 20th of November to 20th of May, and kau, the dry season from 20th of May to 20th November..."

(*Note: See paper, p. 3ff. and readjust the time when the sun makes its zenith passage during the period of invisibility of the Pleiades, in which then May 20th as the zenith passage of the sun took place between April 29 - May 31st 1707 A.D., advancing to May 21st by a day about 1775 A.D. Malo was born about 1793 A.D., Captain Cook was in Hawaii 1778-79 A.D., so that the calendar he was taught by his elders had to be one with which they were operating at least 30 years earlier, about 1763 A.D. well within the time span considered here).

Fornander continues: "...It is known that the Hawaiians, who counted twelve months of thirty days each, intercalated five days at the end of the month Welehu, about the 20th December, which were tabu days, dedicated to the festival of Lono, after which the new year began with the first day of the month Makali'i, which day was properly called Maka-hiki (equivalent to "commencement") and afterwards became the conventional term for a year in Hawaiian, Marquesan, and Society groups" (Fornander, Vol. 6, No. 2:330). This he repeats: "There being only twelve months in the Hawaiian year of 30 days each, or in all 360 days, five days were added at the end of the month Welehu so that the civil or solar year began on the 6th day of the month Makali'i." (Fornander, ibid:332).

This tells us that the month Welehu was really from November-December, and Makali'i was really December-January, when the "civil or solar year" or "new year" began (after the 20th of December, or about the winter solstice, count five days later, about December 25th or December 26th if you start six days after the 20th of December as the 1st of Makali'i).

These five intercalary days were then inclusive of the four days after standstill (solstice) of the sun in which the sun remains as though fixed at the point of standstill before it is seen to move from that point about the fifth day. Now, this civil or solar new year is calculated not only within the critical days of the winter solstice sunrise, but also a a month after the Pleiades is first seen in the evening on the horizon (by one account) or at sunset (heliacal rise at sunset), although Makemson has corrected this to the "first new moon after the first evening rise of the Pleiades on the eastern horizon at sunset". Also, it is well to remember that about November 22nd (November 16th in 1500 A.D.) the Pleiades make their zenith passage over the latitude of Hawaii (21^{o}N lat. about the latitude of Tenochtitlan) at midnight. This suggests that the priests watched for the new moon at the zenith passage of the Pleiades at midnight (culmination of the Pleiades) in November (Welehu), and a month later when the winter solstice sun reached its ~~northern~~ southern limit and began to track ~~south~~ north, the civil solar new year began after the fifth intercalary day and on the first of the month Makali'i (December-January). So Makali'i would, by these instructions, have begun about December 26th, 27th, or 28th since the winter solstice sunrise fluctuates between the 20th and the 23rd of December. In this way then, the civil or solar/tropical year was made to coincide with the sidereal year, from November 22nd to November 22nd, and from December 26th to December 26th, and with the lunar year which falls 11 days short of the solar and sidereal years by waiting for the first new moon to appear on the western horizon in Welehu and the next new moon in Makali'i (December-January).

Note, then, that for the calendars on page 7 of your paper, Table 3:

Count the months backward 6 months from Makali'i remembering that per Fornander, Makali'i was the "6th month", and I asked "6th month from what?" because the season of Kau was six months between Ikiiki (May) and Ikuwā (October), the next season of Ho'oilo was then six months between November (Welehu) and April (Welo), so using that scheme makes Welehu the 2nd month of the winter, not the 6th month. So Makali'i would have to be the 6th month from something else, so let's count another system into this calendar:

Makali'i (December-January) is in this calendar 6 months from July (Hinaia'ele'ele), which means that the users of this 6-month period in the calendar started after the summer solstice in June, and after the heliacal rise of the Pleiades with the sunrise.

Let's count the other periods now backward from the Makali'i months and see what we get:

Hawaii:	Makali'i (December) is 6 months from Hinaiā'ele'ele (July)
Moloka'i:	Makali'i (April) is 6 months from Hilinamā (November)
O'ahu:	Makali'i (October) is 6 months from Hinaia'ele'ele (May)
Kaua'i:	(no Makali'i in calendar)
Kamakau:	Makali'i (April) is 6 months from Hinaia'ele'ele (November)

If we extend these variations to Polynesia, are those systems reflective of the "discrepancy" as present in the Micronesian system described above.

Let's look at the Hawaiian variation specifically for the Pleiades: (I presented this same data in the paper for class last semester, all of it taken out of Malo which were really N.B. Emerson's notes, a good deal of those out of W.D. Alexander) Let's look again at the list you present in your paper for the Pleiades. But let's rearrange those sets so that Makali'i marks the beginning of the sequence.

I'i/Malo

1.	December	(Makali'i) Pleiades
2.	January	(Ka'elo)
3.	February	(Kaulua)
4.	March	(Nana)
5.	April	(Welo)
6.	May	(Ikiiki)
7.	June	(Ka'aona)
8.	July	(Hinaia'ele'ele)
9.	August	(Hilinehu)
10.	Sep.	(Hilinama)
11.	Oct.	(Ikuwa)
12.	Nov.	(Welehu)

Moloka'i

1.	April	(Makali'i) Pleiades
2.	May	(Ka'elo)
3.	June	(Kaulua)
4.	July	(Nana)
5.	Aug.	(Ikiiki)
6.	Sept.	(Ka'aona)
7.	Oct.	(Hilinaehu)
8.	Nov.	(Hilinama)
9.	Dec.	(Welehu)
10.	Jan.	(Ikuwa)
11.	Feb.	(Hinaia'ele'ele)
12.	Mar.	(Welo)

O'ahu

1.	October	(Makali'i) Pleiades
2.	Nov.	(Ka'elo)
3.	Dec.	(Kaulua)
4.	Jan.	(Nana)
5.	Feb.	(Welo)
6.	Mar.	(Ikiiki)
7.	April	(Ka'aona)
8.	May	(Hinaia'ele'ele)
9.	June	(Mahoe-mua)
10.	July	(Mahoe-hope)
11.	Aug.	(Ikuwa)
12.	Sept.	(Welehu)

Kaunamano

1.	Aug.	(Makali'i) Pleiades
2.	Sept.	(Ka'elo)
3.	Oct.	(Ikuwa)
4.	Nov.	(Kaulua)
5.	Dec.	(Nana)
6.	Jan.	(Welo)
7.	Feb.	(Ikiiki)
8.	Mar.	(Ka'aona)
9.	April	(Mahoe-mua)
10.	May	(Mahoe-hope)
11.	June	(Hilina-'ele'ele)
12.	July	(Welehu)

Kamakau (O'ahu;cp. Moloka'i) [Kamakau had family on Moloka'i; was born on O'ahu]

1.	April	(Makali'i) Pleiades
2.	May	(Ka'elo)
3.	June	(Kaulua)
4.	July	(Nana)
5.	Aug.	(Welo)
6.	Sept.	(Ikiiki)
7.	Oct.	(Ka'aona)
8.	Nov.	(Hinaia'ele'ele)
9.	Dec.	(Hilina)
10.	January	(Hilinehu)
11.	Feb.	(Ikuwa)
12.	Mar.	(Welehu)

about the nature of the science of the concrete. Awareness of the regularity and structure of various naturally occurring periodicities provide the schemata[3] for verifying epistemologies in every culture. I suggest, however, that the structural peculiarities of the observable periodicities in the tropics result in a number of shared epistemological features.

Most significant is the fact that, in the tropics, celestial bodies move on straight tracks, rather than around a fixed point in the sky (the north and south celestial poles).[4] The perceptual consequence of this phenomenon is that the sky is divided into two halves. Moreover, as Urton has explained, the point of observational orientation is the movement of celestial bodies in relation to the observer's own fixed locality, rather than a fixed celestial pole.[5] Aveni has shown that all an observer needs are simple devices, such as crossed sticks directed to the horizon or

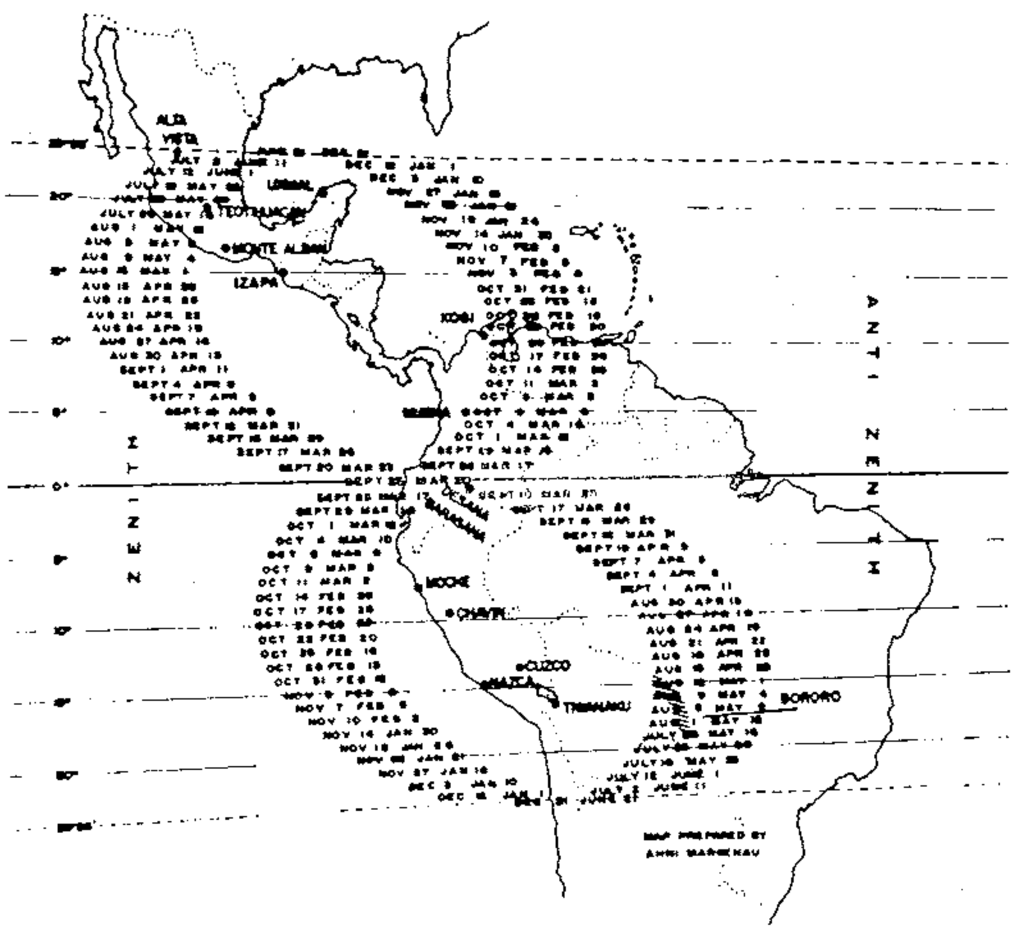


FIGURE 1. Zenith and nadir (antizenith) dates taken from the American Ephemeris and Nautical Almanac for 1980, correct for other years ± 2 days.

Before saying anything further, let's go back to the Babylonia calendar and recover the order of the decan stars in the months:

Iyyar (20th April) Named for Taurus the Bull

4th decan week	4. Mulmul, Pleiades
5th : Apr 30	5. Alpha Carinae in Argo; Alpha and Beta Libra
6th : May 10	6. Lamba in Sagittarius; Kaus Borealis; Delta Sagittarius; Eridanus; Kaus Meridionalis

Sivan (21st May) Named for Gemini the Twins

7th decan week	7. Alpha and Eta Boetes, Arcturus in Boetes; Muphid
8th: 31 May	8. Canis Major (i.e. Sirius); Orion
9th: June 11th	9. Cancer

Tammuz (21st June) Named for Cancer, the Crab

10th decan week	10. Sirius
11th: July 1	11. Stars in Gemini: epsilon, gamma, zeta; alpha and gamma Orionis
12th: July 11th	12. Altara (?) uidentified

Ab (22nd July) Named for Leo the Lion

13th decan week	13. Sagittarius
14th: Aug. 1	14. Castor and Pollux in Gemini; Sagittarius
15th: Aug. 11th	15. Margidda, the Wagon (unidentified)

Elud (23rd August) Named for Virgo the Virgin (note that 2 days have been intercalated into the decan)

16th decan week	16. Biri (unidentified)
17th: Sept 2	17. Ugga, the Raven (unidentified)
18th: Sept 12	18. Supa, Akkadian lunar station in Gemini

Tisri (23rd Sept) Named for Libra, the Balance (note that 1 day has been intercalated into the decan)

19th decan week.	19. Ninmaha (unid.)
20th: Oct. 2	20. Zibanitum, lunar asterism in Libra
21st: Oct. 12	21. alpha and beta Libra; beta and gamma Hydra; upsilon or gamma Scorpio

Marcheswan (23rd Oct) Named for Scorpio, the Scorpion (note that 1 day has been intercalated into the decan)

22nd decan week	22. Lupus; Antares in Scorpio
23rd: Nov. 1	23. Stars in Scorpius: iota, kappa, lambda, upsilon, delta in the lunar zodiac
24th. Nov. 11	24. Antares in Scorpio

Chisleu (22nd Nov) Named for Sagittarius, the Archer

25th decan week	25. (unid.)
26th: Dec. 1	26. Sagittarius
27th: Dec. 10	27. Alpha, beta, and nu Capricornum

Tebet (21st Dec.) Named for Capricorn) (note that 1 day has been intercalated into the decan)

28th decan week	28. Betelgeuse
29th: Dec. 31	29. (unid.)
30th: Jan. 10	30. (unid.)

Dear Conrad,

Let's look at the Pleiades months (Makali'i) and consider the discrepancies:

Hawaii (Ii/Malo)	Makali'i (Pleiades)	December
O'ahu	"	October
Kaunamano	"	August-September
Moloka'i	"	April
Kamakau	"	April-May

While we have these for the Hawaiian Islands per sources you mention, let's also put down the Pleiades months from Micronesia (including Polynesian outliers Nukuoro and Kapingamarangi) Mortlocks, Lamotrek, and general Carolinian calendar):

General (Goodenough)	Mweriker (Pleiades)	June-July
" (Thomas)	Maragar "	May (Na)
Lamotrek	Mairik "	Dec.-Jan.
Mortlocks	Mariker "	May-June
Nukuoro	Matariki "	June

Let's also include the data from the decan months of the Babylonian calendar for 1800 B.C. (Johnson, see Na Inoa Hoku, p. 28-30), remembering that in the Age of Taurus (3800 B.C.), Alcyone in the Pleiades marked the heliacal rise of the constellation at the vernal equinox about March 20th, whereas in the Age of Pisces ca. 1800 B.C. Hamal (alpha Arietes) marked the first decan of the first month at the vernal equinox (i.e., sun in Aries).

4th decan (20th April),1800 B.C. Pleiades April (Taurus)
1st decan of the 2nd month Iyyar (Taurus)
(cp.)1st decan of the 1st month Iyyar (20th March), 3800 B.C. March (Taurus)

This data is what caused me to say in Na Inoa Hoku that there was evidence in the Hawaiian calendar that the priests were observing the Pleiades (on Moloka'i) at heliacal rise with the sun in April-May, since Hawaiian months are from the middle of our months to the next middle, or not equivalent to our months, having another kind of spacing. I also remarked that since the Micronesian calendars referring to the Pleiades favored May-June and June-July, that since these calendars had advanced the Pleiades away from April and March, just as the Babylonian decanate had moved the Pleiades away from March to April--that there was evidence in the Hawaiian calendar that when the missionaries and others were recording calendrical information, the priests were still applying the principle of advancing the calendar to the adjustments required at the vernal equinox, due to the precession of the equinoxes.

Of course, there may be other and better reasons, but that explanation was the only possibility within reach of my limited comprehension. As you will notice if you study the above, Lamotrek associates the period December-January with the Pleiades, and not May-July like its Micronesian neighbors. Why the discrepancy there? Will that explain the December/Pleiades month for Hawaii (Ii/Malo)? And, of course, what justification at all for O'ahu (October/Pleiades) and Kaunamano (August-September/Pleiades)? Note that Kamakau indicates April-May as Makali'i, in agreement with Moloka'i, April (Makali'i/Pleiades).

We cannot make the obvious judgment that the calendar became ossified in Hawaii after travel between the southern and northern hemispheres stopped when migrations ceased and coordination between navigation principles using navigation stars, which were also in a majority of instances calendar stars, was no longer required. Or, what I mean is that we cannot simply say the calendar became ossified due to forgetting. We have to exhaust the possibilities and weigh all of the data only after considering every option of calculation available to an observer.

Let us then weigh the statement made by Malo (p. 30):

"The months in Kau" (i.e. the six-month summer season) "were Ikiiki answering to May, at which time the constellation of the Pleiades, huhui hoku, set at sunrise..."

* N. B. Emerson, in this translation, didn't check what Malo meant with the astronomical facts, which are these. Ikiiki (if I am right in Na Inoa Hoku) answering to May is named for Regulus in Leo (since Jiič, Ititi for the "Rat" constellation in Leo becomes Ikiiki in Hawaiian).

Kamakau, if we may repeat the information again, says that the month April-May is Makali'i, and if we may repeat what Malo says, the month Ikiiki, answering to May, at which time the constellation of the Pleiades, huhui hoku, set at sunrise, and since Moloka'i lists the month of April as Makali'i, then we should try to evaluate this information so that it accords with astronomical facts about two constellations, Leo in May and the Pleiades in April-May. (Actually the Pleiades is an asterism).

In Bryan's star maps please note that Regulus in Leo is in the zenith in May between 6:20 and 8:20 p.m., the zenith of Hawaii. (See attached diagram). In May the Pleiades are rising with the sun, so that they become invisible with the sun during the day, but also, in May the Pleiades for about a month and a few days (32-33 days) is also invisible at night when they are not in the night sky. What Malo was trying to say, and apparently N.B. Emerson did not understand him, or Malo was unable to comprehend the facts himself so as to make them clear to another person, is this:

[In May, apparently, for the last time the Pleiades was observed at sunset above the horizon with the sun, after which time it set before the sun also set. This is the heliacal setting of the Pleiades at dusk. But, this was true also for the Pleiades earlier in April, so that the April-May month as named for the Pleiades as the calendar advanced was sensitive to the heliacal setting of that constellation. In at least two instances, then, this may account for the "discrepancy" of April-May in Kamakau and April (Moloka'i) for the Pleiades.]

Moloka'i is at latitude 21° 10' N, O'ahu at 21° 20' N, and the extreme point of Maui north is at latitude 21°N, so what holds true for these latitudes can be compared to the Meso-american calendars for 21° N (Tenochtitlan).

MAY

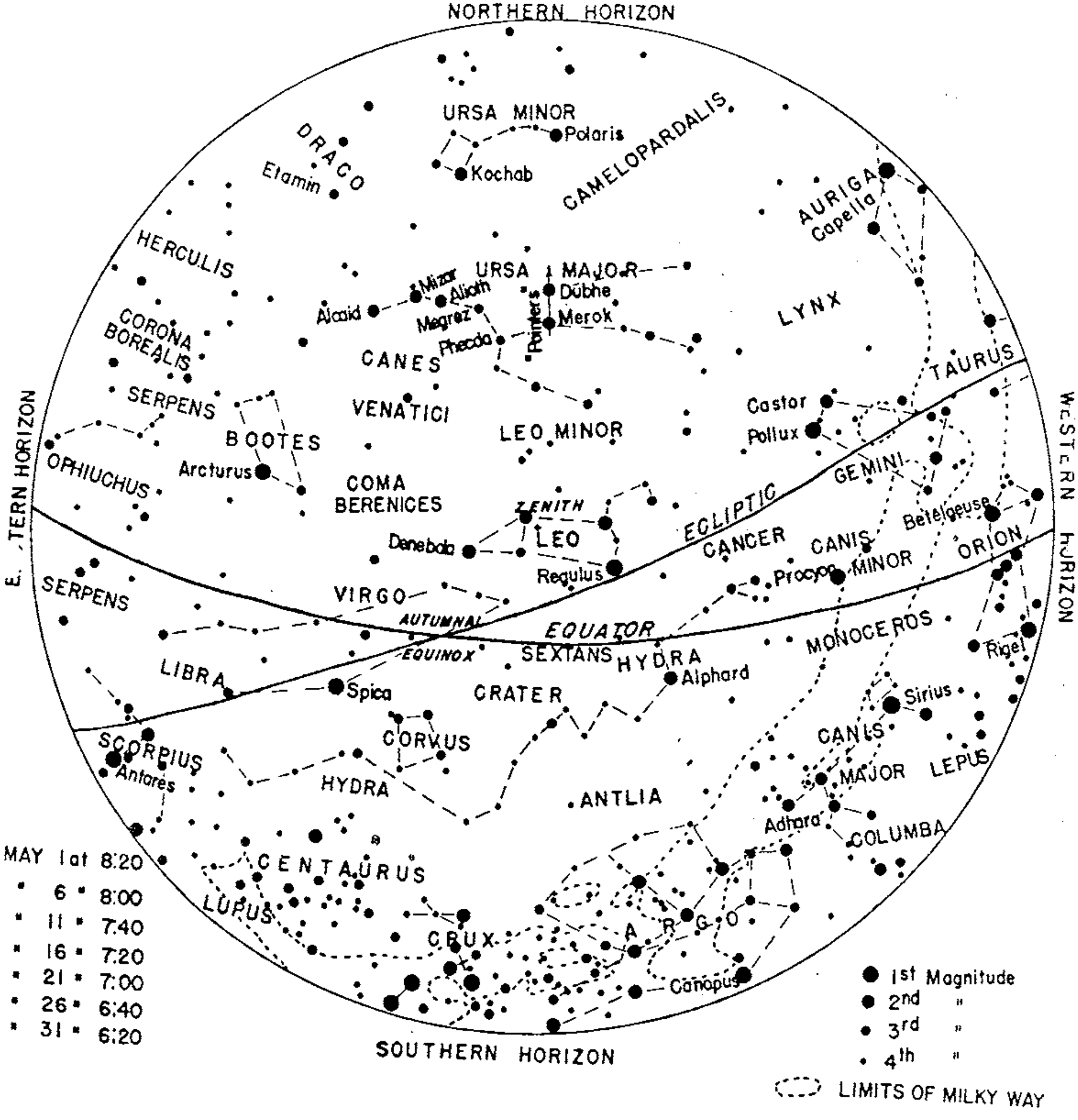

NORTHERN HORIZON
URSA MINOR
Polaris
Kochab
DRACO
Etamin
CAMELOPARDALIS
AURIGA
Capella
HERCULIS
URSA MAJOR
Mizar
Alioth
Dubhe
Alcaid
Megrez
Merek
Phecda
Pointers
LYNX
CORONA BOREALIS
CANES VENATICI
TAURUS
SERPENS
Castor
BOOTES
LEO MINOR
Pollux
GEMINI
OPHIUCHUS
Arcturus
COMA BERENICES
ZENITH
LEO
Denebola
Regulus
ECLIPTIC
CANCER
CANIS MINOR
Procyon
Betelgeuse
ORION
SERPENS
VIRGO
AUTUMNAL EQUINOX
EQUATOR
SEXTANS
HYDRA
Alphard
MONOCEROS
Rigel
LIBRA
Spica
CRATER
Sirius
CORVUS
CANIS MAJOR
LEPUS
SCORPIUS
Antares
HYDRA
ANTLIA
Adhara
COLUMBA
CENTAURUS
LUPUS
CRUX
ARGO
Canopus
SOUTHERN HORIZON
EASTERN HORIZON
WESTERN HORIZON
MAY 1 at 8:20
" 6 " 8:00
" 11 " 7:40
" 16 " 7:20
" 21 " 7:00
" 26 " 6:40
" 31 " 6:20
1st Magnitude
2nd "
3rd "
4th "
LIMITS OF MILKY WAY

Chart 5

So let's go back to Johanna Broda's article, "Astronomy, Cosmovision, and Ideology," in which she gives us two tracks of time to consider for the Mesoamerican calendar, for the Pleiades in 1500 A.D. and 1980 A.D.

April 26-May 29, 1500 A.D. May 3-June 4, 1980 A.D. (period of invisibility)	Pleiades not visible. During this period the first passage of the sun through the zenith occurs at Tenochtitlan (17 May)
April 26, 1500 A.D. May 3, 1980 A.D. (heliacal setting at dusk)	From 18 November until 26 April the Pleiades set earlier each day until, on 26 April, they set in the west before sunset. This means that they disappear from sight for a period of approximately one month, until on 29 May, they begin to rise again in the east at dawn.

Let's apply this to the April-May changes and the May-June changes or alternates per calendars on Moloka'i (and Kamakau) in Hawaii, and the general Carolinian/Micronesian calendars including Lamotrek, Mortlocks, and Nukuoro because the May 29th date good for 1500 A.D. as the heliacal setting of the Pleiades is about May 3 for 1980 A.D. but heliacal rise in the east at dawn with sun is about June 4th. This means that the Micronesian calendar recorded by Goodenough in 1953 and by Thomas in 1983 has been advanced at a rate of calculation which is expected, about a day every 68.5 years:

May 3, 1980/ June 4, 1980 A.D.	Heliacal setting at dusk of the Pleiades/Heliacal rising at dawn of the Pleiades
May 2, 1911/ June 3, 1911 A.D.	
May 1, 1843/ June 2, 1843 A.D.	
April 30, 1775/ June 1, 1775 A.D.	1778-79 Captain Cook in Hawaii
April 29, 1707/ May 31, 1707 A.D.	
April 28, 1638/ May 30, 1638 A.D.	
April 27, 1619/ May 29, 1619 A.D.	
April 26, 1551/ May 28, 1551 A.D.	1500 A.D. Umi-a-Liloa
April 25, 1483/ May 27, 1483 A.D.	1450 A.D. Liloa — 1492 A.D PLEIADES IN ZENITH
April 24, 1414/ May 26, 1414 A.D.	
April 23, 1345/ May 25, 1345 A.D.	1350 A.D. Last Polynesian fleet
April 22, 1296/ May 24, 1296 A.D.	
April 21, 1227/ May 23, 1227 A.D.	
April 20, 1158/ May 22, 1158 A.D.	
April 19, 1089/ May 21, 1089 A.D.	
April 18, 1020/ May 20, 1020 A.D.	992 A.D. PLEIADES IN ZENITH
April 17, 951/ May 19, 951 A.D.	AT LATITUDE 20°N KAWAIHAE – KAHOOLAWE,
April 16, 882/ May 18, 882 A.D.	PUU MOA'ULA NUI
April 15, 813/ May 17, 813 A.D.	MAKALI'I
April 14, 744/ May 16, 744 A.D.	
April 13, 675/ May 15, 675 A.D.	
April 12, 606/ May 14, 606 A.D.	
April 11, 538/ May 13, 538 A.D.	
April 10, 469/ May 12, 469 A.D.	450 A.D. (carbon date Ka'ū)
April 9, 400/ May 11, 400 A.D.	

April 8,	331/ May 10, 331 A.D.	Heliacal setting at dusk of the
April 7,	262/ May 9, 262 A.D.	Pleiades/Heliacal rising at dawn
April 6,	193/ May 8, 193 A.D.	of the Pleiades
April 5,	124/ May 7, 124 A.D.	
April 4,	55/ May 6, 55 A.D.	I. A.D Age of Pisces/Pisces in
April 3,	13/ May 5, 13 B.C.	First Point of Aries/
April 2,	82/ May 4, 82 B.C.	Vernal Equinox (March 20-22)
April 1,	150/ May 3, 150 B.C.	Marquesas settled between 100 B.C.
March 31,	219/ May 2, 219 B.C.	and 300 A.D.
March 30	287/ May 1, 287 B.C.	
March 29	356/ April 30, 356 B.C.	
March 28	424/ April 29, 424 B.C.	
March 27	493/ April 28, 493 B.C.	
March 26	561/ April 27, 561 B.C.	
March 25	630/ April 26, 630 B.C.	
March 24	698/ April 25, 698 B.C.	
March 23	777/ April 24, 777 B.C.	
March 22	845/ April 23, 845 B.C.	
March 21	915/ April 22, 915 B.C.	
March 20	983/ April 21, 983 B.C.	
March 19	1022/ April 20,1022 B.C.	
March 18	1090/ April 19,1090 B.C.	
March 19	1159/ April 18,1159 B.C.	
March 18	1227/ April 17,1227 B.C.	1200 B.C. La Pita Pottery/Tonga
March 17	1296/ April 16,1296 B.C.	
March 16	1364/ April 15,1364 B.C.	
March 15	1433/ April 14,1433 B.C.	
March 14	1501/ April 13,1501 B.C.	
March 13	1570/ April 12,1570 B.C.	
March 12	1575/ April 11,1575 B.C.	
March 11	1644/ April 10,1644 B.C.	
March 10	1712/ April 9,1712 B.C.	
March 9	1781/ April 8,1781 B.C.	1800 B.C. Age of Aries/Calendar
March 8	1849/ April 7,1849 B.C.	set to Hamal in the vernal equinox
March 7	1918/ April 6,1918 B.C.	
March 6	1986/ April 5,1986 B.C.	2000 B.C. Age of Aries/end Age of
March 5	2055/ April 4,2055 B.C.	Taurus
March 4	2123/ April 3,2123 B.C.	
March 3	2192/ April 2,2192 B.C.	
March 1	2260/ April 1,2260 B.C.	
Feb. 28	2329/ March 30,2329 B.C.	
Feb. 27	2397/ March 29,2397 B.C.	
Feb. 26	2466/ March 28,2466 B.C.	
Feb. 25	2534/ March 27,2534 B.C.	
Feb. 24	2603/ March 25,2603 B.C.	
Feb. 23	2671/ March 24,2671 B.C.	
Feb. 22	2740/ March 23,2740 B.C.	
Feb. 21	2808/ March 22,2808 B.C.	
Feb. 20	2877/ March 21,2877 B.C.	
Feb. 19	2945/ March 20,2945 B.C.	3000 B.C. Age of Taurus/ Calendar
Feb. 18	3014/ March 19,3014 B.C.	set to Alcyone in the Pleiades

The foregoing readjustment for the period of invisibility of the Pleiades, from the heliacal setting at dusk (April 26, 1500 A.D. - May 3, 1980 A.D.) and heliacal setting at dawn (May 29, 1500 A.D. - June 4, 1980 A.D.), based on 68.5-days per one-day advance in the calendar and 7 such days advance in a period of 480 years between 1500 A.D. and 1980 A.D., is my own calculation, but I urge you to check this out with a competent astronomer or someone who is a whiz at calendrical computation. I'm purely an amateur in such matters, but I have an interest in finding out the truth. If I am wrong, then point it out to me. Unless people are willing to make the effort we will never know nor be sure we understand anything, nor should we rest until we have shed more light on a matter as debatable as calendrical discrepancies in Hawaiian calendars recorded after 1820 A.D.

Now let us return to another critical factor which belongs in the same commentary given by Broda for 21°N latitude, which is:

During this period, April 26-May 29, 1500 A.D., or May 3-June 4, 1980 A.D., on May 17th (1500 A.D.), the sun makes its first zenith passage. It will make another on its return south, but what makes this first zenith passage critical for the Pleiades in relation to the sun, as the Mesoamerican priests observed, is that on November 16th 1500 A.D. the Pleiades passed the zenith at midnight. Broda readjusts that zenith passage of the Pleiades at midnight to 22 November, 1980 A.D., but she adds another critical factor about the zenith pass of the Pleiades at midnight: "This date coincides with the nadir of the sun at Tenochtitlan (six months after 17 May)".

This brings up the zenith/anti-zenith matter. Sometime in the past, perhaps since 3000 B.C., maybe earlier (we will never know when), the calendar-keepers must have discovered that the Pleiades and the sun at their zenith passages were on the meridian great circle at noon and midnight opposite each other, and that these events split the year into half. Put simply, when the Pleiades transited the meridian at midnight, then the sun was at nadir. Seems simple doesn't it? Well, it's not, because the zenith/antizenith times happen twice for the sun each year, once going north and again going south. More about this later.

Were the Hawaiians in their observations sensitive to the zenith passage of the sun at noon during the year? We only have to look at the names they give to noon: <u>awakea</u> and <u>kau ka lā i ka lolo</u>. <u>Awakea</u> 'noon', means "as-the-celestial-equator" (ka piko o Wakea, 'the navel of Wakea', Wakea being 'sky father'), the sun at noon is overhead, but when is the 'sun over the brain' (kau ka lā i ka lolo) so that it casts no shadow? This is the definition for <u>kau ka lā i ka lolo</u>, the sun is over the brain and casts no shadow. This can happen only during the zenith passages of the sun at noon twice a year in the Hawaiian Islands, as Bryan remarks, between May and July. (See attachments).

So we need to ask astronomers these questions per the calendrical discrepancies found in both the Micronesian and Polynesian calendars (Hawaiian) vis a vis the Pleiades. During the two zenith passages of the sun in Hawaii and Mexico at 21° N, or the anti-zeniths of the sun for the latitudes 2° - 12° N (Micronesia) and 19° - 23.5° N (Hawaiian Islands from Hawaii to Nihoa), what stars or constellations are opposite? These would vary, wouldn't they, for the latitudes, or would it matter?

For comparable data let's turn away momentarily from Broda and consider what Urton has to say about Peru (Urton, Gary, "Astronomy and Calendrics on the Coast of Peru") between 3° and 18° S where the summer months are between November to May:

"They (the Chimu) do not count the year by Moons, nor by the course of the sun, but rather from the rise of the stars which we call the Cabrillas (the Pleiades) and which they call Fur...The Pleiades begin to rise at sunset on 18 November. They then undergo helicacal setting (at dusk) on 19 April, are invisible for about 45 days, and reappear in the east in the early morning of 3 June. Therefore the rise of the Pleiades just after sunset...(30 November) marks the beginning of the good fishing season and their heliacal rise in the early morning hours of 3 June marks the approximate end of the good fishing season...disappearance of the Pleiades from late April till early June..." (p. 237)

Noteworthy in the above is the longer period of invisibility of the Pleiades for about 45 days, since Peru sees less of the Pleiades ~~to~~ the north, above the equator.

Urton lists the dates of one zenith passage and nadir of the sun (Chimu area): zenith passage of October 14 and anti-zenith (nadir) sun of April 10 (p. 238). Does this mean that the Pleiades transit the zenith at midnight for the Chimu on April 10th? Or are the Pleiades on the meridian with other stars that transit at midnight? Urton continues:

"At a latitude of 7° 40' south, the sun passes through the zenith of Santiago de Cao on 12 October and 3 March, and it passes through the nadir point at midnight on 9 April and 7 September..."

"Before proceeding, we should note the heliacal setting and rising dates for the Pleiades:

18 November	heliacal rise at dusk
19 April	heliacal rise at dusk
3 June	heliacal rise at dawn

"And the dates of the zenith/nadir passages of the sun in Huarochiri (12° 10' south latitude):

Zenith	16 February	Nadir	19 August
	26 October		22 April

"From our study here, we are led to hypothesize that, along the Peruvian coast, the orientations incorporated in public architecture might include the rising and setting points of the Pleiades, theSouthern Cross, Orion's Belt, and the zenith and nadir sun (all of which will change with the latitude)..." (p. 245).

What do Peruvian calendrics have to do with the Hawaiian calendars? In the region which applies to Polynesian calendrics, Peru occupies the same tropical area between 3° and 18° S latitude that corresponds to most of Polynesia within the tropics (except for New Zealand, but the Maoris before they discovered Aotearoa had occupied Central Polynesia, (8° S (Marquesas) to 18° S (Tahiti) and lower (Australs, Gambiers). Only between 100 A.D. and thereafter do they come north to Hawaii and go south to New Zealand, most of their successful colonizing and settling done between 500 and 1350 A.D. to marginal points (Easter Island, Hawaii, New Zealand). (Please readjust these dates if you have other newer archaeological dates for the settlement of marginal Polynesia). The point is that these areas work with an older calendrical system south of the equator and time zones that apply as well as periodicities of the celestial bodies concerned. Nevertheless, if the Polynesians there had already positioned their calendrics to the zenith and nadir of the sun with respect to the Pleiades, we must see how those calendars could have been arranged between 3000 B.C. and 1350 A.D. versus how they were readjusted between 1350 A.D. and (for Hawaii) 1820 A.D. (I'm using this date because this is when the missionaries arrived, introducing other elements into Hawaiian education).

It is important now to recognize another important factor. Most of the Micronesian calendars we have looked at are not below the equator, but in a region roughly between 2° and 12° N. Yet, the corresponding elements, such as names of the ruling stars of pertinent months in the Hawaiian calendar, bear more Micronesian than Melanesian cognates. I pointed this out in Na Inoa Hoku, since it applied that any system of time which accompanied navigation must have come into Polynesia from a more northerly route, or if the Polynesians came into contact with a Micronesian system they must have borrowed from it. Or, is what we see in Polynesia a reflection of what happened before the separation of Micronesia, Melanesia, and Polynesia from essentially what was a Proto-Malayan system? Does the Hawaiian system reflect something that they may have found here in the earlier aboriginal culture, provided they came across Micronesians already settled in Hawaii and subjugated them? This is beyond the scope of our present study, but we must put out every feeler for explanation of relationships with and deviations from calendars operating between 2°-12° N latitude (Micronesia) and 0°-23.5° S (Polynesia) pertinent to Hawaii at 19°-23.5° N.

To help us out with the zenith/anti-zenith (nadir) information with respect to the sun and the dates for each latitude between 23.5° S- 23.5° N I have attached a chart made by Isbell (Isbell, Billie J. "Culture Confronts Nature in the Dialectal World of the Tropics" (p.355). The dates of zenith passage are on the left, nadir on the right; the inner dates correspond to each other as zenith is to nadir, so the outer dates correspond to each other. (See attachment).

periodicities in the tropics result in a number of shared epistemolo; features.

Most significant is the fact that, in the tropics, celestial bodies m on straight tracks, rather than around a fixed point in the sky (the nc and south celestial poles).[4] The perceptual consequence of this pheno non is that the sky is divided into two halves. Moreover, as Urton has plained, the point of observational orientation is the movement celestial bodies in relation to the observer's own fixed locality, ra than a fixed celestial pole.[5] Aveni has shown that all an observer ne are simple devices, such as crossed sticks directed to the horizor

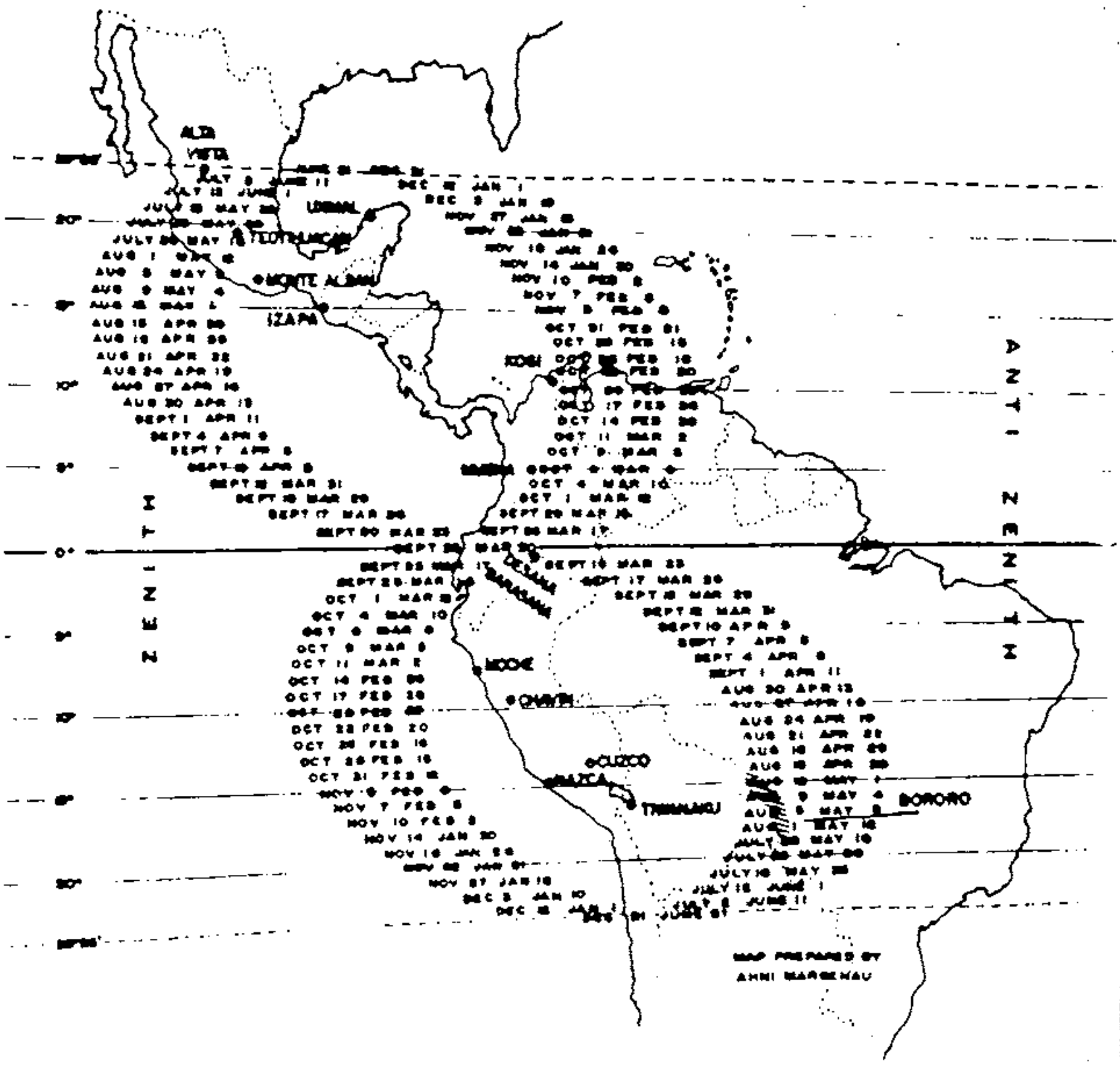


FIGURE 1. Zenith and nadir (antizenith) dates taken from the American Ephemer Nautical Almanac for 1980, correct for other years ± 2 days.

How does this additional data help us to understand calendrical discrepancies? We are better able to coordinate the calendrical possibilities between 0° and 23.5° N as those apply to Hawaii and Micronesia (2°- 12°N). The area critical to calendars from the Carolines inclusive of Lamotrek and Polynesian outliers Nukuoro and Kapingamarangi is between 5° and 10° N latitude, so let's space out the information from Isbell pertinent to the region of the Carolines:

Zenith (sun)		Antizenith/Nadir		Latitude	
March 26	(sun going north)	Sept. 29	[Tarawa]	2°N	(Micronesia)
March 29		Oct. 1	[Gilberts]	3°N	[Butaritari]
March 31		Oct. 4	[Abaiang]	4°N	
*April 3		Oct. 6		*5°N	Carolines
April 5		Oct. 9		6°N	"
April 9		Oct. 11		7°N	"
April 11		Oct. 14		8°N	"
April 13		Oct. 17		9°N	"
*April 16		Oct. 20		*10°N	Carolines
April 19		Oct. 22		11°N	
April 22		Oct. 26		12°N	
April 25		Oct. 29		13°N	Guam
April 28		Oct. 31		14°N	Tinian, Rota, Saipan
May 1		Nov. 3		15°N	Marianas
May 4		Nov. 7		16°N	
May 8		Nov. 10		17°N	
May 12		Nov. 14		18°N	
*May 16		*Nov. 18		*19°N	Ka'u, Hawaii
*May 20	(Teotihuacan)/	*Nov. 22	(Pleiades/zenith	*20°N	Kohala, Hawaii
*May 25	(Tenochtitlan)	*Nov. 27	at midnight)	*21°N	Molokai, Oahu
*June 1		*Dec. 3		*22°N	Kaua'i
June 11		Dec. 12		23°N	
*June 21	Summer Solstice	*Dec. 21	Winter Solstice	*23.5°N	Nihoa
July 2	(sun going south)	Jan. 1	Pleiades/zenith	23°N	
*July 12		*Jan. 10	7:40 p.m.	22°N	Kaua'i
*July 16	(Uxmal) (Tenochtitlan)	*Jan. 16	7:20 p.m.	21°N	O'ahu/Moloka'i Maui
*July 25	(Teotihuacan)	*Jan. 21	7:00 p.m.	20°N	Kohala, Hawaii
*July 28		*Jan. 26	6:40 p.m.	19°N	Ka'u, Hawaii
Aug. 1		Jan. 30	6:20 p.m.	18°N	
Aug. 5		Feb. 2		17°N	
Aug. 9		Feb. 5		16°N	
Aug. 12		Feb. 8		15°N	Marianas
Aug. 15		Feb. 11		14°N	
Aug. 18		Feb. 15	[Rongerik, Rongelap	13°N	Marshalls]
Aug. 21		Feb. 18		12°N	
Aug. 24		Feb. 20		11°N	
Aug. 27		Feb. 23		10°N	Carolines
Aug. 30		Feb. 26		9°N	" Ulithi
Sept. 1		Feb. 28		8°N	" Lamotrek
Sept. 4		Mar. 2		7°N	" Satawal, Pona
Sept. 7		Mar. 5	[Talait]	6°N	" Kusaie
Sept. 10		Mar. 8	Palmyra Is.	5°N	" Mortlocks

Zenith (sun)		Anti-zenith/nadir		Latitude	
Sept. 12		Mar. 10		4°N	Fanning Is.
Sept. 15		Mar. 12		3°N	
Sept. 17		Mar. 15		2°N	Christmas Is.
Sept. 20	Autumn Equinox	Mar. 17		1°N	
Sept. 23		Mar. 20	Vernal Equinox	0°E	Equator
Sept. 26		Mar. 23	[Nonouti, Gilberts]	1°S	
Sept. 29		Mar. 26	[Tabiteuea, Beru]	2°S	
Oct. 1		Mar. 29		3°S	Peru (Chimu)
Oct. 4		Mar. 31		4°S	"
Oct. 6		Apr. 3	[Ontong Java]	5°S	"
Oct. 9		Apr. 5	[Nanomanga, Ellice Is.]	6°S	"
Oct. 11		Apr. 8		7°S	Santiago de Cao
Oct. 14		Apr. 11	Funafuti [Ellice Is.]	8°S	Marquesas
Oct. 17		Apr. 13	[Solomon Is.]	9°S	Nukulaelae [Ellice Is.]
Oct. 20		Apr. 16	[Guadalcanal]	10°S	Tongareva (Penrhyn)
Oct. 22		Apr. 19		11°S	
Oct. 25		Apr. 22		12°S	
Oct. 28		Apr. 26	'Upolu; Savai'i [Samoa]	13°S	
Oct. 31		Apr. 28	Ofu, Olosenga [Manu'a]	14°S	Cuzco (Peru)
Nov. 5		May 1	Aunu'u, Tutuila	15°S	Futuna (Horne Is.),
Nov. 7		May 4	Vanua Levu, Fiji	16°S	Rangiroa, Tuamotu 15°S. Raroia, Tuam.
Nov. 10		May 8	[Vanikoro, Santa Cruz Is.]	17°S	Huahine, Taha'a, Borabora
Nov. 14		May 12	[Eromanga, New Hebrides]	18°S	Tahiti; Viti Levu, Fiji
Nov. 18		May 16	Kandavu, Fiji	19°S	Niue Is.; Vava'u, Tonga
Nov. 22		May 20	Mukutavaka	20°S	Ha'apai Is., Tonga
Nov. 27		May 26	[Espiritu Santo]	21°S	
Dec. 3		June 1		22°S	Tongatapu
Dec. 12		June 11		23°S	
Dec. 21	Winter Solstice	June 21	Summer Solstice	23.5°S	
Jan. 1	(sun going north)	July 2		23°S	Mangareva (Gambier)
Jan. 10		July 12		22°S	Mangaia, Rarotonga
Jan. 16		July 16	[New Hebrides, Espiritu Santo]	21°S	
Jan. 21		July 25		20°S	Atiu
Jan. 26		July 28	Akiaki, Vahitahi (Tuam.)	19°S	Aitutaki
Jan. 30		Aug. 1	Ana'a (Tuam.)	18°S	Tahiti; Hao, Tuam.
Feb. 2		Aug. 5		17°S	Makemo, Tuam.; Amanu
Feb. 5		Aug. 9		16°S	Raroia, Tuam.
Feb. 8		Aug. 12		15°S	
Feb. 12		Aug. 15		14°S	Cuzco (Peru)
Feb. 15		Aug. 18		13°S	
Feb. 18		Aug. 21		12°S	
Feb. 20		Aug. 24		11°S	Fatuhiva
Feb. 23		Aug. 27		10°S	Motane, Tahuata, Hiva Oa
Feb. 26		Aug. 30		9°S	Nukuhiva
Feb. 28		Sept. 1	[Atafu, Tokelau Is.]	8°S	Marquesas
Mar. 2		Sept. 4		7°S	
Mar. 5		Sept. 7		6°S	
Mar. 8		Sept. 10		5°S	
Mar. 10		Sept. 12		4°S	
Mar. 12		Sept. 15		3°S	
Mar. 15		Sept. 17		2°S	

Zenith (sun)		Antizenith/nadir		Latitude
		Sept. 19		$1^{o}S$
Mar. 17				
Mar. 20	Spring Equinox	Sept. 20	Autumn Equinox	$0^{o}E$

If we may retrack our study here a bit, so that we can evaluate how important this data is, we have some evidence for regarding the April-May Makali'i Pleiades month for Moloka'i as (probably) an awareness of the heliacal rise and set of the Pleiades which begins and ends its period of invisibility. Three events would be then crucial, if this is the case:

1. The last time at which the Pleiades is seen in the western sky before sunset (i.e., heliacal setting at dusk).

2. The first time at which the Pleiades is seen in the eastern sky rising just before sunrise (i.e., heliacal rising at dawn)

3. The zenith passage of the sun at noon during the period when the Pleiades is invisible at night

4. The corresponding observation of the Pleiades when it is first rising in the east when the sun is setting on or about Nov. 1st (1500 A.D.) and Nov. 7th (1980 A.D.) (i.e., the Pleiades is rising and setting opposite the sun.

5. The corresponding antizenith position of the sun (nadir), or if the Hawaiians didn't know that, at least the observation of the Pleiades when it was on the meridian at midnight (Nov. 16th in 1500 A.D.; Nov. 22nd in 1980 A.D.); i.e. zenith passage of the Pleiades at midnight.

6. The period of the Pleiades' visibility from Nov. 18 (1500 A.D.) to April 26 (Nov. 22-May 3) through the night until it is invisible.

This last item has to be looked at more carefully, because it is the period when the discrepancies, if they are discrepancies, took place in assigning Makali'i to October (Oahu) and to August-September (Kaumamano). We cannot say that October is important because of the zenith/antizenith position of the sun vis-a-vis the Pleiades because that data fits the Carolinian and other Micronesian data between $3^{o}N$ and $14^{o}N$. We may be able to argue that it is "ancestral" in Polynesian calendars since the zenith/antizenith data fits the critical Polynesian region, and if this were the case then the disposition of the Pleiades with respect to October could have been "ossified" into the calendar as a residual aspect. But it's not likely to be the reason, if another more probable one exists. The answer may lie in the selection of times when the Pleiades may transit the zenith but not at midnight during the months when it is visible at night. In other words it belongs in the clock time of a particular month, so we would have to consider the Pleiades

1. October - Pleiades in the zenith at sunrise

in the night clock between 1 November and 3 May.

June 1st. Sunrise is about 5:48 a.m. (see Bryan, Stars Over Hawaii)
*(Note: readjust because these are just working data)

June 4th. First morning rise of the Pleiades (acc. Broda for 21°N lat.)
*(Note: the stars rise four minutes earlier each day)

June 21st. Sunrise about 5:49 a.m. (sun rising later)
*(17 days x 4 minutes = 68 minutes = 1 hour and 8 minutes; the Pleiades have risen before the sun by 1 hour and 8 minutes; they are now 15° above the horizon; subtract the time = 4:41 a.m)

July 1st Sunrise about 5:52 a.m. (sun rising later)
* (10 days x 4 minutes = 40 minutes, so readjust to August)

Aug. 1st.- Aug. 31st Sunrise about 6:04 a.m. (sun rising later)
* (30 days in July + 1 in August = 31 days x 4 minutes = 124 minutes)
(124 minutes + 40 minutes + 8 minutes = 172 minutes)
(172 minutes = 2 hours and 32 minutes)
By August 1st, the Pleiades had risen another 20 minutes,or 1 hour, so that the Pleiades by August 1st had risen 2 hours before daylight and 30° above the horizon about 4:04 a.m.
By August 31st, the Pleiades had risen another 2hours = 30° above the horizon, therefore by August 31st the Pleiades had risen 60° above the horizon by 2:00 a.m.

Sept. 1st - Sept. 31st Sunrise about 6:14 a.m. (sun rising later)

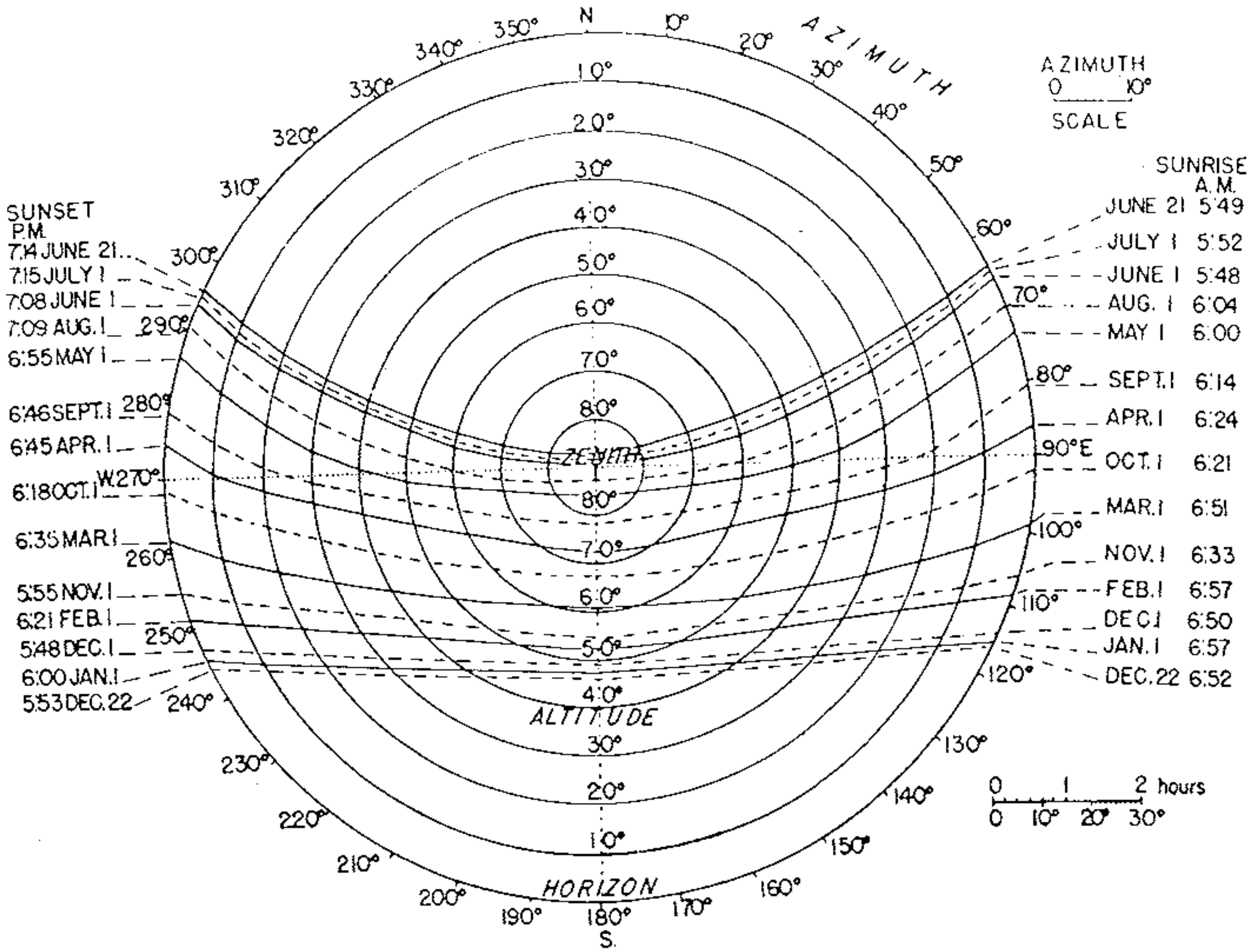
Oct. 1st Sunrise about 6:21 a.m. (sun rising later)
*(31 days x 4 minutes = 124 minutes = 2 hours and 4 minutes)
(The Pleiades have risen to the zenith at ~~12:00~~ 6:21 am, therefore the sun blocks them out at sunrise while they are in the zenith)

Any calendrical observation of the Pleiades for August-September, and September-October would then be oriented to the position of the Pleiades in the eastern sky before morning, and would recognize the zenith position of the Pleiades about October 1st when the sun rose at daylight.

But we are still in the process of finding out other probabilities, and as we remember that any calculation of the sidereal month within the context of a sidereal year would reference not only the sun but the moon. Where the moon was in the Pleiades at the critical times as we have investigated here is an important consideration, since as Makemson and others have stated, the Pleiades year, the makahiki was calculated from the first new moon after the first rise of the Pleiades with the sun in the evening. Figure it out for 1500 A.D. and when Malo, Ii, and Kamakau were living. At this point I am suffering from exhaustion.

Aloha nui loa,

R.K.Q.



How the Sun appears to move.

The apparent path of the Sun across the sky shifts from south to north and back again in the course of a year. The reason for this is that the earth's axis is not perpendicular to its orbit around the Sun. During our summer the earth's northern pole is tipped a little toward the Sun. Six months later it is tipped about the same amount away from the Sun, which shines more directly on the southern hemisphere. The angle of this tip from the perpendicular amounts to about 23½ degrees. At some time of year the Sun shines directly down on every part of the earth's surface from 23° 27′ North latitude, on June 21 or 22, to 23° 27′ South latitude on December 21 or 22. These parallels mark the limits of the Tropics. The Sun is in the constellation of Cancer when it appears to be furthest north, so this limit is called the Tropic of Cancer. The southern limit is called the Tropic of Capricorn because the Sun is located in Capricornus when furthest south.

The diagram, above, shows the way the sun appears to cross the sky as seen from the latitude of Hawaii. The curved lines from side to side represent the tracks along which the Sun appear to move on the first day of each month, and when furthest north (about June 21 or 22), and furthest south (December 21 or 22). The months when the Sun is moving northward (January to June) are solid lines; those when it is moving southward (July to December) are dash lines.

From this diagram it is possible to tell the direction of the Sun at any hour of any day throughout the year, as seen from Hawaii. The observer is directly below the dot marked "zenith." The direction of the Sun can be measured as azimuth and altitude. The azimuth is measured around the horizon, starting from the north point; each ten degrees is marked. The altitude of the Sun above the horizon can be estimated from the target of concentric circles, ten degrees

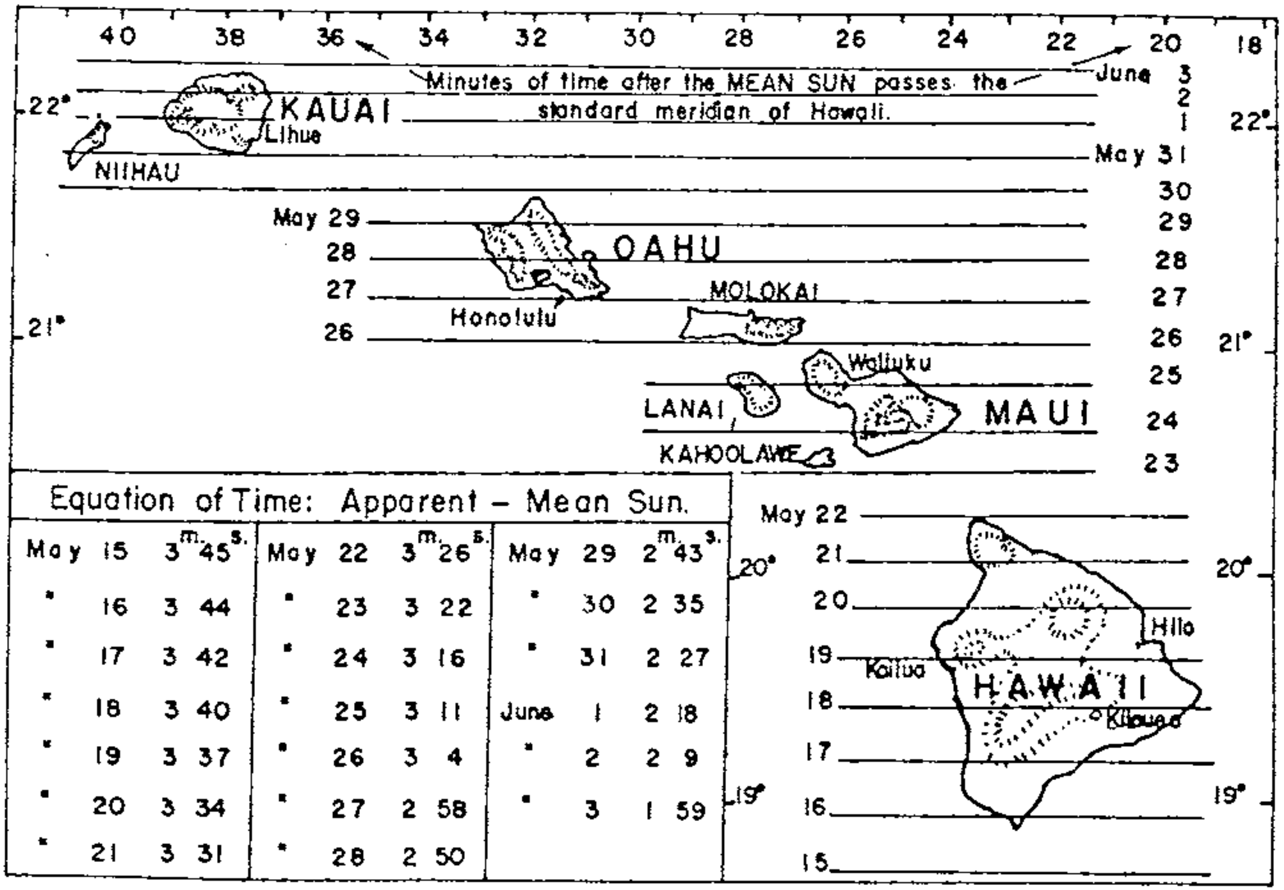
6. WHEN THE SUN CASTS NO SHADOW

During the last half of May, each year, and again in mid-July, an event occurs in the Hawaiian islands which cannot take place in any part of the mainland United States. The Sun passes directly over head, and for an instant a slender, vertical object, such as a flagpole, will cast no shadow.

It is not hard to predict just when and where the Sun will be exactly over head, with the help of a Nautical Almanac. The accompanying diagram shows how it will take place in 1955

The series of parallel lines across the sketch map of the Hawaiian islands represents the path of the Sun directly over head on the different dates, from May 15 to June 2. This gives some idea of the daily amount of shift of the Sun northward, and also shows that the amount decreases as the Sun approaches the Tropic of Cancer, which is about 23½ degrees north latitude.

The position of these lines is not exactly the same each year. The reason for this is that the year does not contain an



Equation of Time: Apparent – Mean Sun.

Date		m. s.	Date		m. s.	Date		m. s.
May	15	3 45	May	22	3 26	May	29	2 43
"	16	3 44	"	23	3 22	"	30	2 35
"	17	3 42	"	24	3 16	"	31	2 27
"	18	3 40	"	25	3 11	June	1	2 18
"	19	3 37	"	26	3 4	"	2	2 9
"	20	3 34	"	27	2 58	"	3	1 59
"	21	3 31	"	28	2 50			

Three of the calendars show that Makali'i (Hawaii,O'ahu, and Kamakau) are six months from Hinaia'ele'ele. Only in the Moloka'i calendar is Makali'i six months from Hilinama, but in two of them, Kamakau and Moloka'i that sixth month is November. So whether the month name is Hilinama or Hinaia'ele'ele for Oahu/Moloka'i, Makali'i is six months from November. Since the O'ahu/Moloka'i designation of Makali'i as April, we know from the astronomy that April is a month when the Pleiades are setting in the evening with the sun, and November is a month when they are rising as the sun sets in the evening. So calendars on Moloka'i and O'ahu are sensitive to the heliacal rising of the Pleiades with the sun in the morning, the heliacal setting of the Pleiades with the sun in the evening in April, and then to the evening rise of the Pleiades on the eastern horizon when that constellation appears as the sun sets: i.e., the heliacal rise of the Pleiades at dusk. It also suggests that on O'ahu and Moloka'i, the priests could also be watching for the zenith/ passage of the sun between April/May and the zenith passage of the Pleiades in November. (See discussion in other paper).

The discrepancy is in the month names for November, whether for Hilina-mā or Hinaia'ele'ele, but let's not get to that problem now. We'll get bogged down in comparative calendars from Tonga and Tokelau.

3. P. 4. the intercalary month every 3 years. Be careful here, because W.D. Alexander is not talking about the sidereal year in relation to the sidereal month (i.e.sidereal lunation). He is talking about an intercalary month, the 13th month, to bring the lunar calendar into line with the sidereal year, so if the lunar year based on the synodic lunations is short of 11 days each year, at the end of three years, there would be a shortage of 33 days, so that you would intercalate one additional synodic lunation of 29.5 days, then intercalate another 2.5 days. So there would be a 13th-month, but W.D. Alexander doesn't know how this worked because it would shift the year at the end, if you didn't realize or know that this would not happen if that 13th month was integrated into the sidereal year, because there are already 13 sidereal months in a sidereal year. How does this happen?

One sidereal lunation is 27 and 1/3 day, so you would have to multiply 27 by 13 and 1/3 = 360 days = 1 year + 5-day intercalation to match the solar year. This means that they didn't add a sidereal month; they kept the synodic lunation which added up to 354 days, then they add'another 6 days to account for the 360-day sidereal year based on the sidereal lunation, then they added the 5-day intercalary period after the winter solstice.

So, since the Hawaiians had a decan week, these 11 intercalary days were not difficult to insert, since they would add a week of ten days + 1 day to the intercalation at the end of every lunar year of 12 months (synodic) and only five days at the end of every sidereal year of 13 months.

4. P. 4. You quote me as saying that the sidereal system "allowed for the computation of time passage by stars that was "irrespective of the lunar calendar, and the 36-anahulu year".

What I meant then was this: too often the Hawaiian calendar was called a "lunar calendar", which it is and is not, and the 36-anahulu year became a standard without reference to what made it 36 ten-day weeks, because the 36-ten-day weeks are computed relative to sun positions in the tropical year as the sun moves north and south, but it makes sense to know that this begins when the sun rises in certain stars in the ecliptic and to which stars the months were determined in the tropical year.

Readers have to know what reasoning lies behind a statement of this nature used in the context in which it now means something else, and this is true of the other quote: "duration of time of a star's passage through the sky determined the duration of the mon[th]s and of the year", which really means that the people calculating are aware of how long the periods are of the circuits as they are watching them from their latitude and their meridian, and that these circuits change as you go south and north, and over periods of years due to precession also change when the sun no longer appears in them at the same times. To develop the calendars as we see them took brains.

5. P. 4. For this reason, the statement you make, "The question is why was the sidereal calendar codified and how did the discrepancies arise?" has arisen because what looks like an ossification is really in a state of constant readjustment, as all calendars must be or they are soon in error.

6. P. 6. Also, for the same reason: "If a calendrical system developed in the southern Pacific based on navigation stars as Johnson and Mahelona (1975) have suggested...." is a misunderstanding.

What I indicated was that the calendar stars were also, for the most part, also stars used in navigation, but not in either case are all calendar stars navigation stars or vice versa.

It is axiomatic that navigators who in their wanderings went both north and south and east/west in their tropical zone would have encountered precisely those differences, changes, and readjustments that are expected to happen, but what they kept intact were those parts of a system they had been using and which they had to reprogram not only to the place to which they came but also to the space visible overhead at night and what is there still familiar to them and what is new.

7. P. 8 "I'i tells us the Makahiki year began in the month of August which he names as Hilinehu. Then "In the month of October, Ikuwa... they waited for the appearance of the Huhui (PLeiades) over the forest..."

See the discussion in the otherpaper, p.11.

even number of days. There are 365 days and a fraction which is very nearly one quarter. Calendar makers com- ensate for the fraction by adding a day to February every fourth year, which is called leap year. On such a year, the whole system of dates on the diagram shifts northward one day. During the following three years it gradually shifts southward again. This is shown by the zigzag diagram across the top of the map, which is drawn to about the same scale as the daily shift of the Sun over Oahu. To find approximately where the Sun will be on a certain date from now to 1966, measure the difference on this diagram between the date and the line through 1955, and shift the system of daily lines accordingly.

So much for the path of the sun for a certain day. What about the time of day when the Sun will cast no shadow? Hawaii keeps a sort of perpetual daylight saving time. Hono- lulu standard time is more than 30 minutes ahead of local time at Honolulu. The scale of minutes across the top of the chart shows the difference between our standard time and the local time at any place in the islands. For example, at Hilo the difference is about 20 minutes; at Lanai City, about 28 minutes; at Pearl Harbor exactly 32 minutes after noon, Standard time, before it is local noon. To find the difference where you live, locate the spot on the map and run a vertical line up to the scale.

As we note on the diagram, this is the interval of time after the "mean" Sun passes the standard meridian (150 degrees west longitude, some 540 miles east of Honolulu) before it reaches your local meridian.

The mean Sun is the one which astronomers have invented so that they do not have to keep changing the clocks con- stantly. The real Sun, the one you see in the sky, appears to move first faster and then slower than this uniform, imaginary Sun, which you cannot see. The mean Sun and the real or "apparent" Sun cross the meridian at the same instant only four times a year (April 17, June 15, September 2, and De- cember 28). The difference between them at other times may amount to as much as 16 minutes, some parts of the year ahead, at others behind.

This difference is called the Equation of Time. A table giving the difference for each day between May 15 and June 3, appears on the chart. At this time of year the apparent Sun is ahead of the mean Sun. If you observe the instant the real Sun is on the meridian and then wait the given number of minutes and seconds, it will be local noon. To get the Standard Time at that instant, you add the number of minutes that you are west of the standard meridian (as shown on the scale at the top of the chart). If you have the standard time and want to know when the real Sun will be on the meridian, you take the number of minutes that you are west of the standard meridian and subtract from it the equation of time for the date. That gives you the number of minutes after standard noon before the real Sun is on your meridian. Doing this on the right day for your locality gives you the time at which a vertical object should cast no shadow.

If you want to figure out when and where the Sun will be directly over head in July, do just as I did. Hunt up a copy of the American Ephemeris and Nautical Almanac—there are copies at the University of Hawaii library, the Hydrographic office, and on most ships. In part I, under statistics for the Sun, you will find given the apparent declination of the Sun and the equation of time for every day of the year. This, of course, is given for Greenwich. It takes the Sun about 10 and a half hours to get from Greenwich to Honolulu, so you have to interpolate the figures for declanation by 10.5/24ths of the difference from one day to the next, which for your convenience is given in seconds of arc in small figures to the right of the column. The equation of time also can be inter- polated, if you want it closer than the nearest minute, the daily difference being given in seconds of time.

In case you do not have access to a copy of this valuable reference book on the heavenly bodies, here are the approximate dates when the Sun will be over head during its journey south- ward in July:

Over Kauai—about July 11 to 14.
Over Oahu—about July 15 to 18.
Over Molokai—about July 19.
Over Maui—about July 20 to 22.
Over Hawaii—about July 23 to 29.

The equation of time during this period is minus 4 minutes to minus 6 minutes. In May the apparent Sun is ahead of the mean Sun. In July the mean Sun is ahead of the apparent Sun.

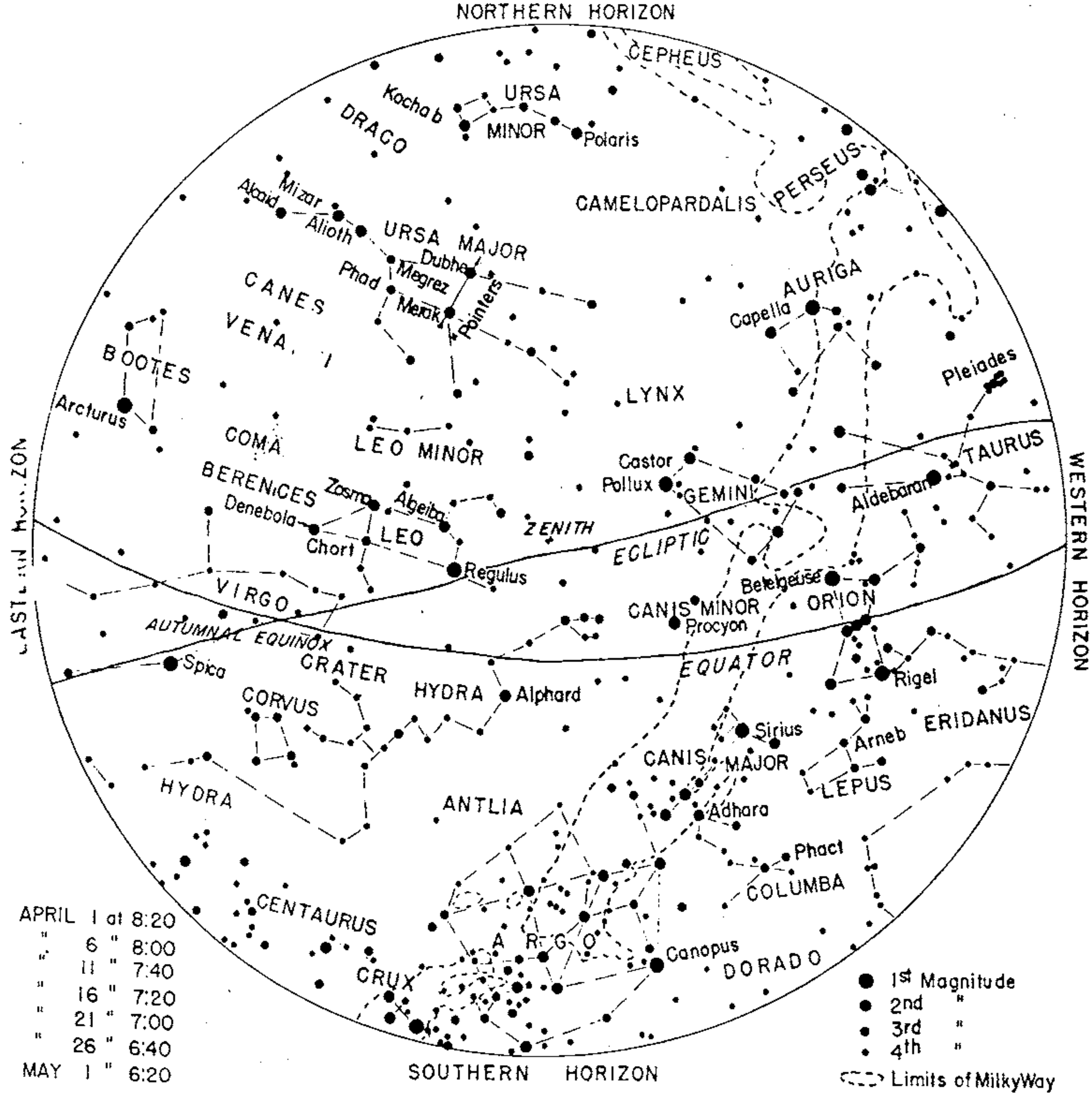
7. REVISING THE CALENDAR

Many centuries ago primitive man became aware of that unit of time which we call the day. So long as it was daylight he could roam about in search of food. When night came he had to take refuge within a cave or in a tree to avoid savage beasts.

It was a long time before he dared venture out at night. Then it was that he learned about the phases of the moon and the manner in which that body moves around the earth, or rather, at that time, just across the sky. These phases and movements became for him another measure of time; the month was born.

The seasons came and went; the heat of summer, the changing color of the leaves in autumn, the cold of winter, the fragrant blossoms which burst forth in spring. Of all these man became aware, particularly when he started to harvest

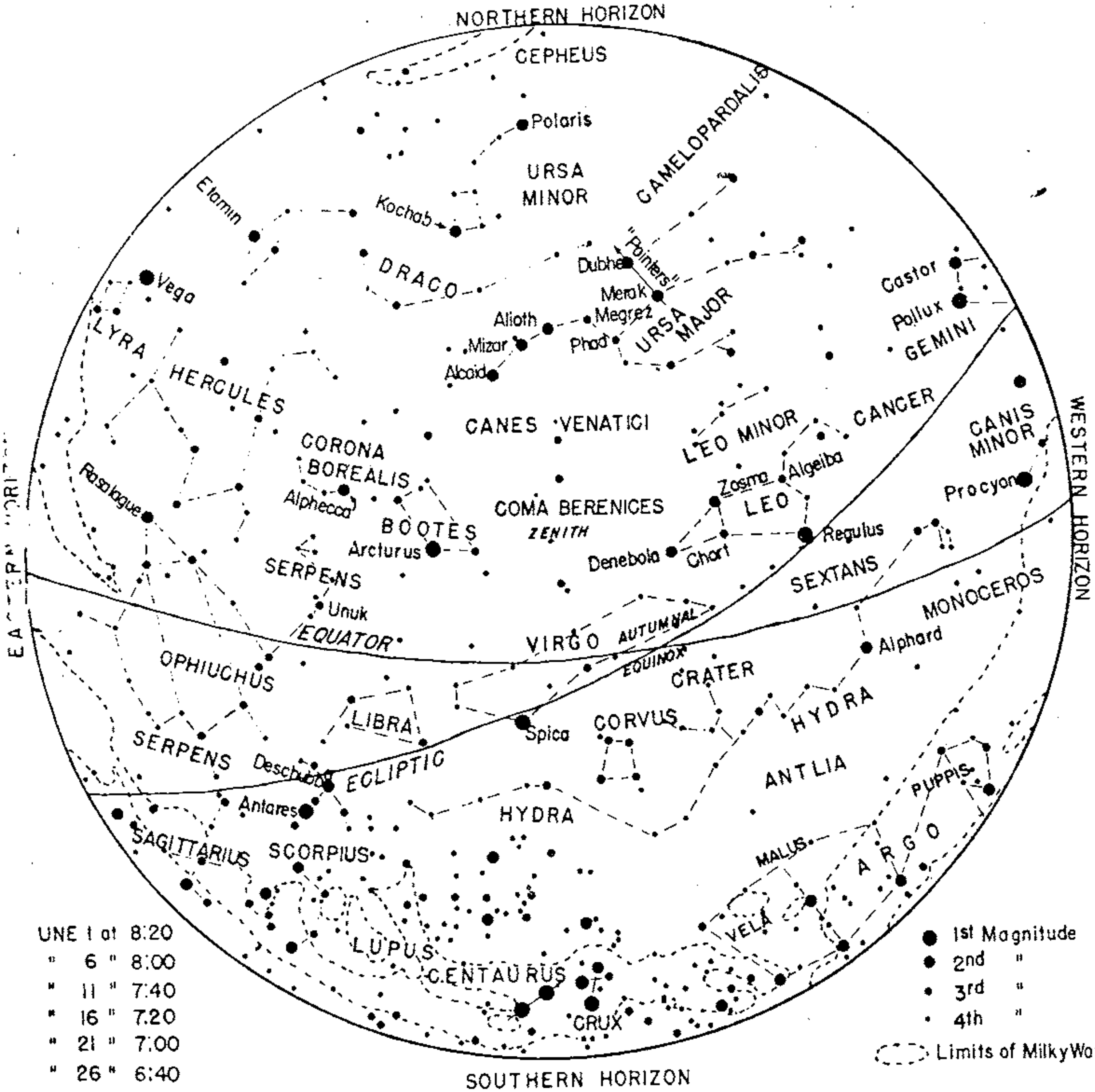
APRIL



APRIL	1 at	8:20
"	6 "	8:00
"	11 "	7:40
"	16 "	7:20
"	21 "	7:00
"	26 "	6:40
MAY	1 "	6:20

Chart 4

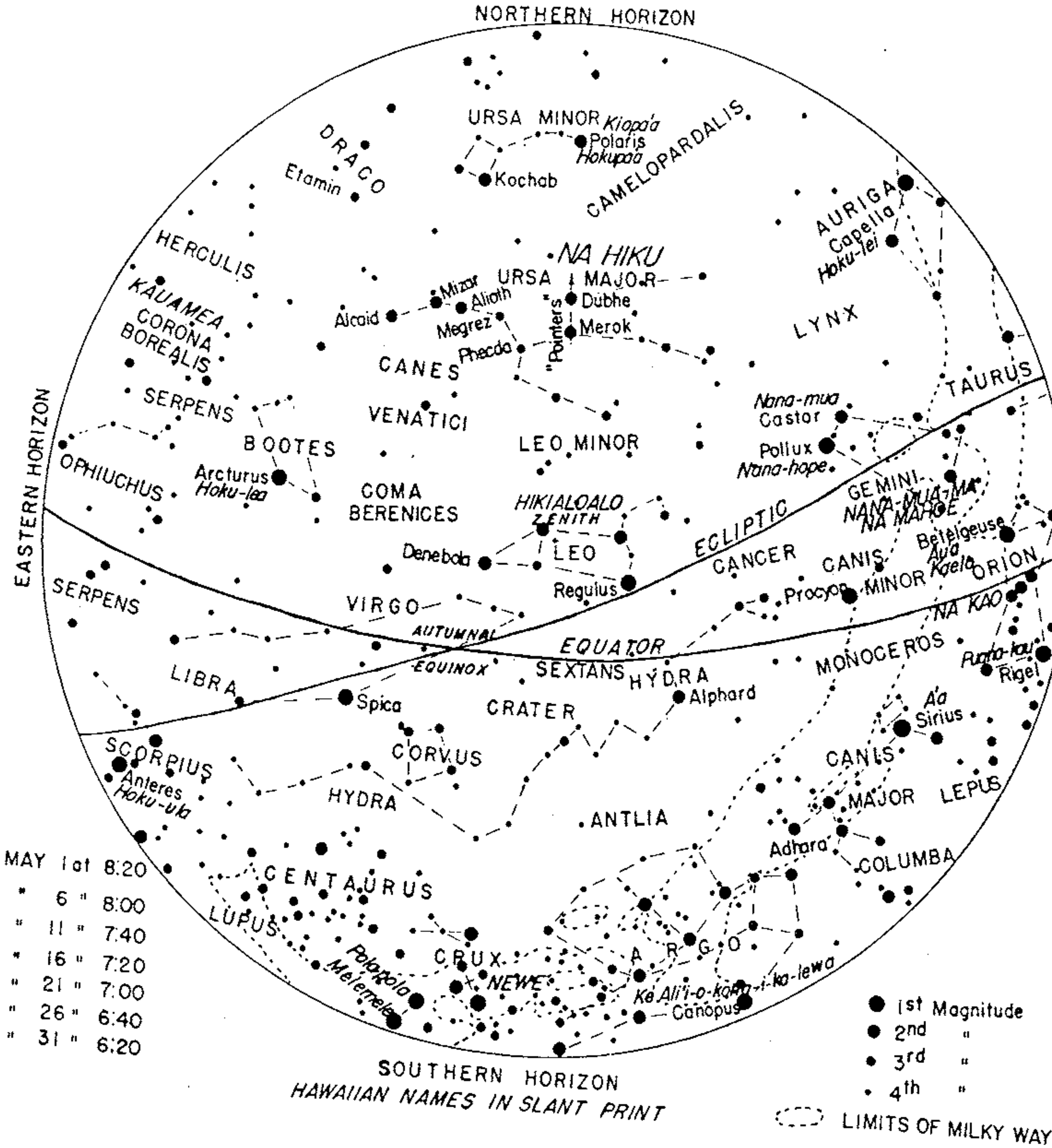
JUNE



UNE 1 at 8:20
" 6 " 8:00
" 11 " 7:40
" 16 " 7:20
" 21 " 7:00
" 26 " 6:40

● 1st Magnitude
● 2nd "
• 3rd "
• 4th "
Limits of Milky Way

Chart 6


NORTHERN HORIZON
URSA MINOR
Kiopa'a
Polaris
Hokupaa
Kochab
DRACO
Etamin
CAMELOPARDALIS
AURIGA
Capella
Hoku-lei
NA HIKU
HERCULIS
KAUAMEA
CORONA BOREALIS
Mizar
Alioth
URSA MAJOR
Dubhe
Merok
Alcaid
Megrez
Phecda
Pointers
LYNX
CANES VENATICI
TAURUS
SERPENS
Nana-mua
Castor
Pollux
Nana-hope
BOOTES
LEO MINOR
OPHIUCHUS
Arcturus
Hoku-lea
COMA BERENICES
GEMINI
NANA-MUA-MA
NA MAHOE
HIKIALOALO
ZENITH
Betelgeuse
Aua
Kaela
Denebola
LEO
ECLIPTIC
CANCER
CANIS MINOR
ORION
EASTERN HORIZON
WESTERN HORIZON
SERPENS
Regulus
Procyon
VIRGO
AUTUMNAL EQUINOX
EQUATOR
NA KAO
LIBRA
SEXTANS
HYDRA
MONOCEROS
Puana-kau
Rigel
Spica
Alphard
CRATER
A'a
Sirius
SCORPIUS
Anteres
Hoku-ula
CORVUS
CANIS MAJOR
LEPUS
HYDRA
ANTLIA
Adhara
COLUMBA
MAY 1st 8:20
" 6 " 8:00
" 11 " 7:40
" 16 " 7:20
" 21 " 7:00
" 26 " 6:40
" 31 " 6:20
CENTAURUS
LUPUS
CRUX
NEWE
ARGO
Polapola
Melemele
Ke Ali'i-o-kona-i-ka-lewa
Canopus
1st Magnitude
2nd "
3rd "
4th "
LIMITS OF MILKY WAY
SOUTHERN HORIZON
HAWAIIAN NAMES IN SLANT PRINT

Kaho'olawe Island Conveyance Commission

SUPPLEMENT TO

Consultant Report No. 9

Kaho'olawe's Potential Astro-Archaeological Resources

By:

Rubellite Kawena Johnson

MAKALI'I AND MAKAKILO:

ARCHAEOLOGICAL SURFACE ASSESSMENT OF TWO RIDGE SITES ABOVE HAKIOAWA KAHO'OLAWE ISLAND

By: Aki Sinoto

INTRODUCTION

The following report presents the results of an archaeological assessment of two sites conducted during September 8 and 9, 1992. This work took place in conjunction with Dr. Rubellite Kawena Johnson's preliminary investigations of the potential archaeoastronomical resources of Kaho'olawe (Johnson, 1993) conducted under the auspices of the Kaho'olawe Island Conveyance Commission.

These sites are located nearly due south of Hakioawa on the northeastern slopes of Kaho'olawe, two ridgelines to the east, and inland of Oawawahie Bay (Fig. 1). They are located between the 140 and 180 meter elevations, roughly 200 meters apart, on the same ridgeline below Pu'u Kolekole.

The potential archaeoastronomical significance of these two sites came to light when a copy of a hand-drawn map annotated by Maui historian Inez Ashdown (Johnson, 1993:3.2) was given to Dr. Johnson for review. On this map, two areas in the proximity of the two sites are labelled *Makakilo* and *Makali'i*. Dr. Johnson defines the traditional Hawaiian archaeoastronomical association of both names:

1) *Makali'i* is the name given to the constellation Pleiades, and

2) *Makakilo* means sky-watcher/observer, as of stars/fish/weather phenomena (Johnson, 1993:4).

The current assessment was prompted by the sighting of what appeared to be two man-made *ahu* or markers from the northeastern promontory, above the *Hale-o-Lono* heiau at Hakioawa Bay (Fig. 2). On one of the previous field trips during the March closure period, Drs. Abraham Piianaia and R. Kawena Johnson had observed these two features from Hakioawa as profiles on a distant ridgeline, but had been unable to inspect them closeup due to time constraints.

Hence, the objective of the current phase of work was to locate and document the two "*ahu*" sites on the ground. Dr. Johnson set forth these two tasks:

1) Check photographed "pillars" (*ahu*) sighted to see if they were man made or natural stone objects, and

2) Ascertain their precise location so that the ridge name and location could be more accurately determined (Johnson, 1993:1).

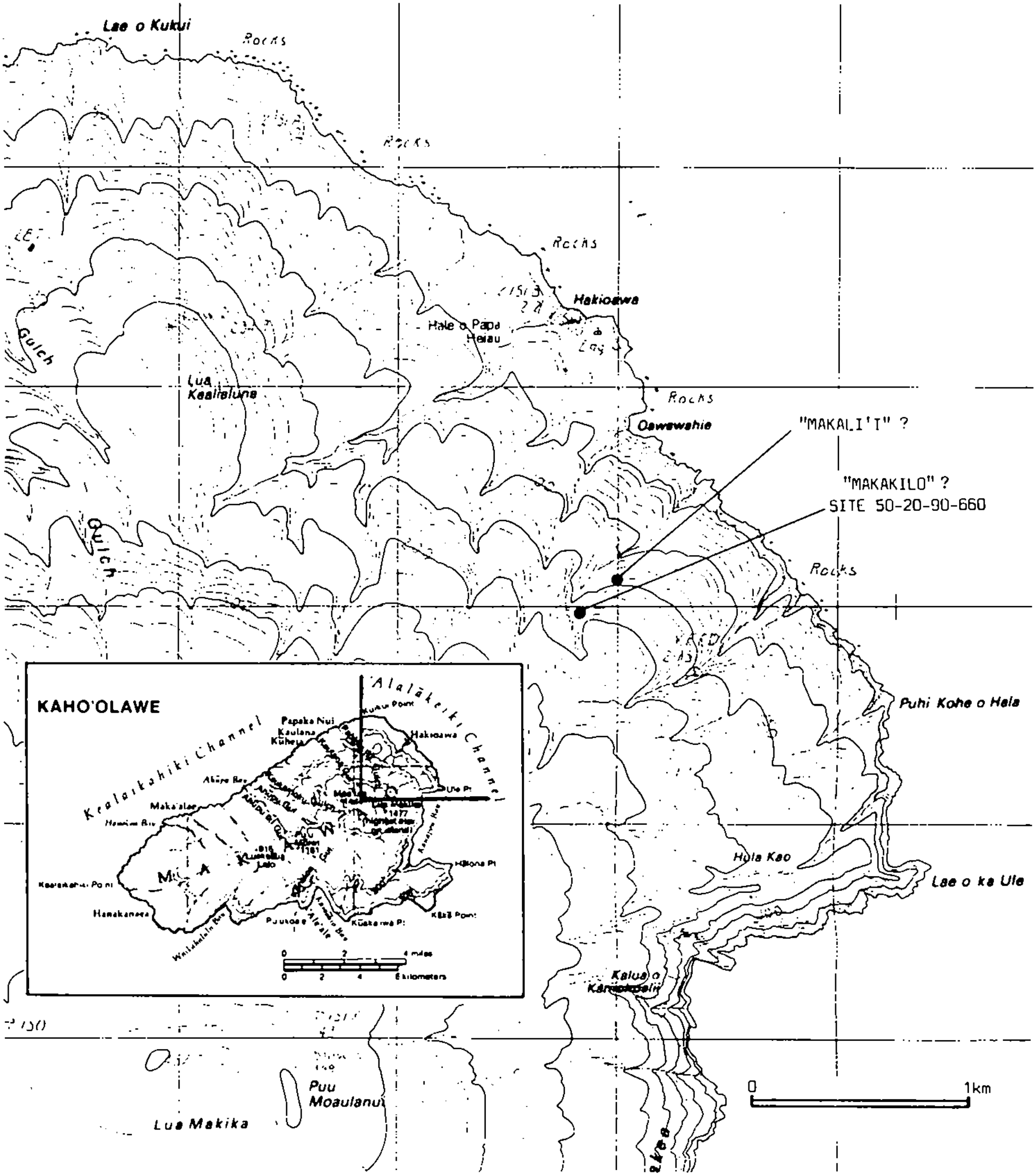


Figure 1. Portion of Topographic Map of Kaho'olawe Showing Site Locations

Figure 2. View South from Hakioawa Showing the Two Sites (arrows).

RESULTS OF SURVEY

On Wednesday, September 9, 1993, with the kind and able assistance of USN Lt. Vernon Young (Officer in Charge), who accompanied us as driver, guide, and military chaperone; we approached these sites from above. We took the jeep, as far as possible, down the hardpan slopes north of Lua Makika to about the 250 meter elevation and walked the rest of the way past Pu'u Kolekole.

SITE 50-20-90-660

The upper site had been previously recorded by Dr. Robert Hommon during the inventory survey in 1980 and designated as Feature A of Site 50-20-90-660. The Historic Places Inventory Form, with Hommon's description of the site, is attached as Appendix A. Notable aspects pointed out by Hommon were the absence of other sites in the vicinity for at least 100 meters in any direction and the evidence for a number of activites at the site; including procurement, preparation, and consumption of food; and the maufacture of basaltic glass and basalt artifacts.

Three features are present at Site 660, however, for the purposes of the current assessment, only Feature A will be considered.

Feature A

A partially walled, oval platform occurs on the top of a small knoll roughly 300 meters northwest of Pu'u Kolekole. This platform, the main component of the three feature complex, incorporates outcrops and large boulders. It is partially enclosed on the north, east, and south by a semi-circular, stacked boulder and cobble wall (Fig. 3). Its measures 5.5 meters north/south and 7.5 meters east/west. The downslope side stands .90 meters high and the upslope side ranges in height from .60 to .70 meters. The stacked, boulder and cobble wall ranges in width from .80 to 1.0 meter. Neither the interior nor exterior of the wall is faced. The interior floor of the structure, raised .30 to .50 meters above the surrounding ground surface, consists of flat soil with some small stones. A scatter of basalt flakes occurs along the southern quarter of the interior floor area. Clusters of outcrop boulders occur on the eastern and western sides and are partially incorporated into the structure. Sparse midden scatters are apparent on the surrounding ground surface with a small concentration occuring on the eastern exterior of the structure.

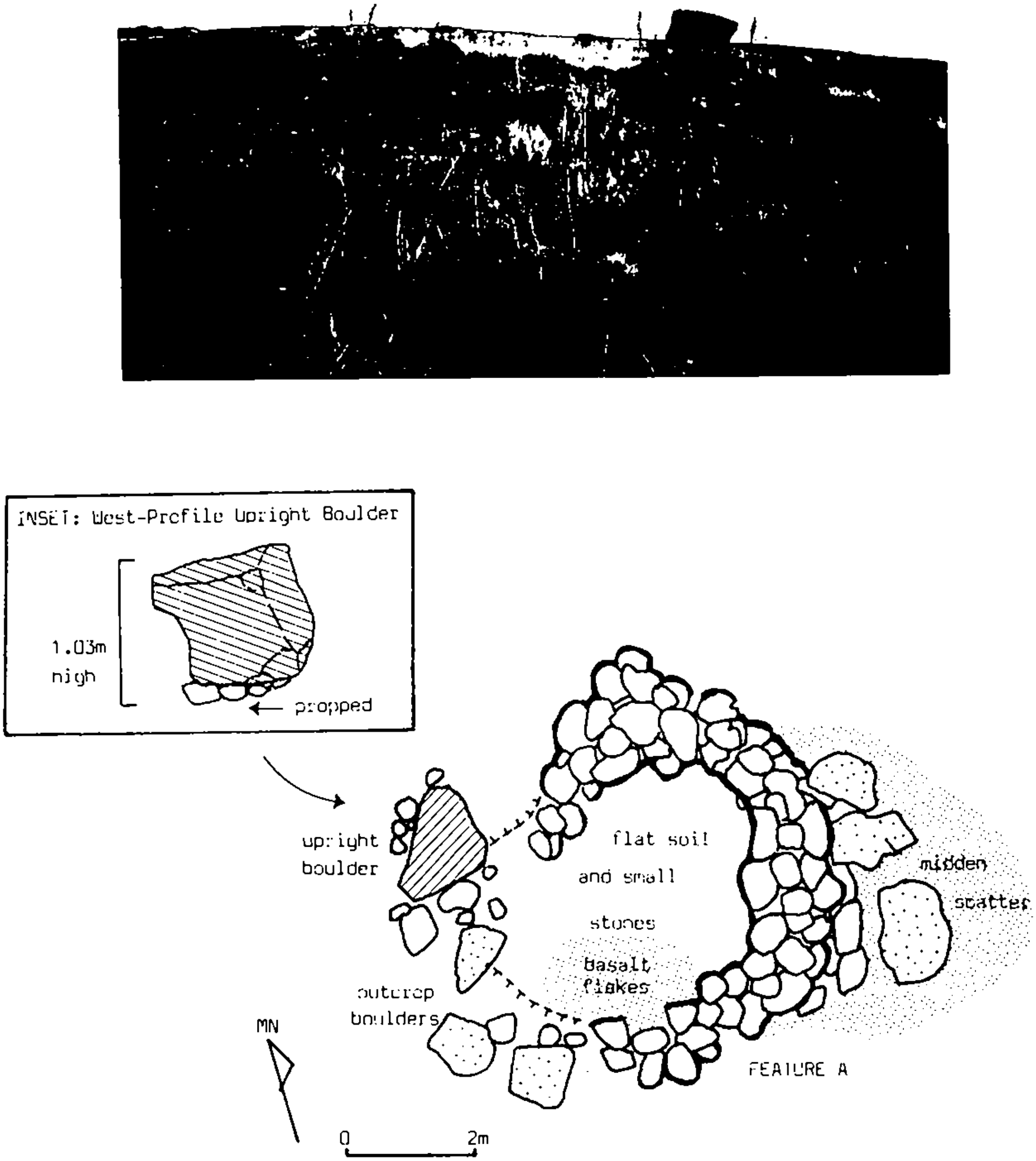


Figure 3. (top) View of Site 50-20-90-660 from the east.
(bottom) Plan View of Site 660 and Profile of Boulder.

On the western end of the structure stands a large, natural boulder, unmodified, but deliberately propped up into the present position by smaller stones wedged under its base (see Fig. 3). The stone stands 1.03 meters high. 1.2 meters wide, and 1.6 meters long. Based on its position on the knoll and its viewscape (Fig.4), this boulder was determined to be the upper "*ahu*" or "Makakilo" (?), as seen from Hakioawa (see Fig. 2).

Natural Boulder

Located roughly 200 meters below Site 660 on the same ridge, is a large naturally occuring, weathered basalt boulder (Fig. 5). The face-like appearance, as viewed from the northwest, can characterize this boulder as anthropomorphic (Fig. 6). The roughly cylindrical boulder stands 2.9 meters high, 2.6 meters wide, and 1.7 meters deep. Its position and viewscape (Fig. 7) determined this natural, but conspicuous, feature as the lower "*ahu*" or "Makali'i" (?). No evidence of cultural activity was observed in the vicinity of this site.

DISCUSSION

The procedures undertaken in support of archaeoastronomical inquiry, during the September fieldtrip, fulfilled the objectives set forth by Dr. Johnson following the March sighting. On site documentation was accomplished with one site determined to be man-made and the other natural. The ridgeline that they occupy and their individual locations were accurately established.

The boulder at Site 50-20-90-660, Feature A and the anthropomorphic boulder located 200 meters downslope were verified to be the two "*ahu*" sighted on the distant ridgeline during the previous field trip. Whether, these two features are indeed the "Makali'i" and "Makakilo" indicated on Inez Ashdown's map could not be conclusively established. Never-the-less, the following factors provide support for such an argument:

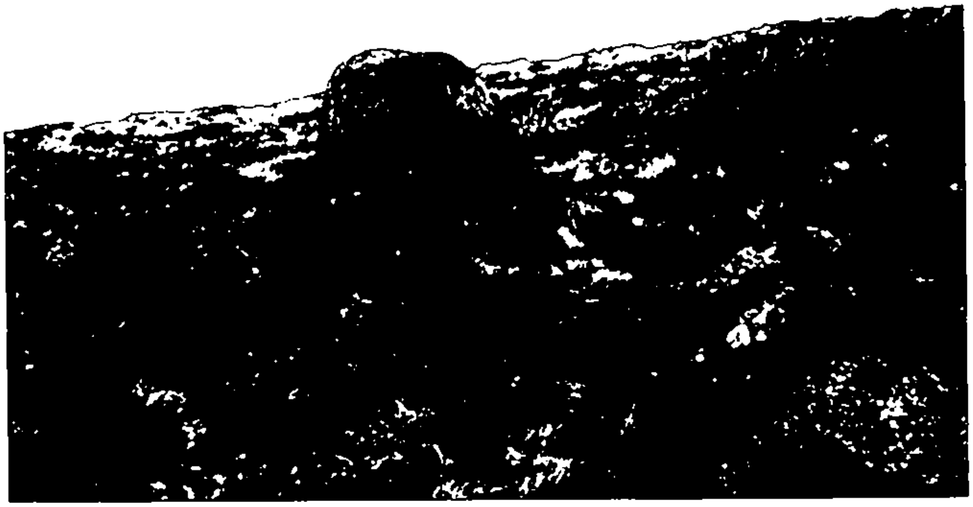
1) the isolated occurrence of the two sites as indicated by the archaeological evidence,

2) the prominent visibility of these two features from the coast, and

3) the spatial association relative to Inez Ashdown's map.

Relevant archaeoastronomical evidence is presented by Dr. Johnson and the reader is referred to her report.

Figure 4. View North towards Hakioawa (arrow) from Site 660 Boulder.



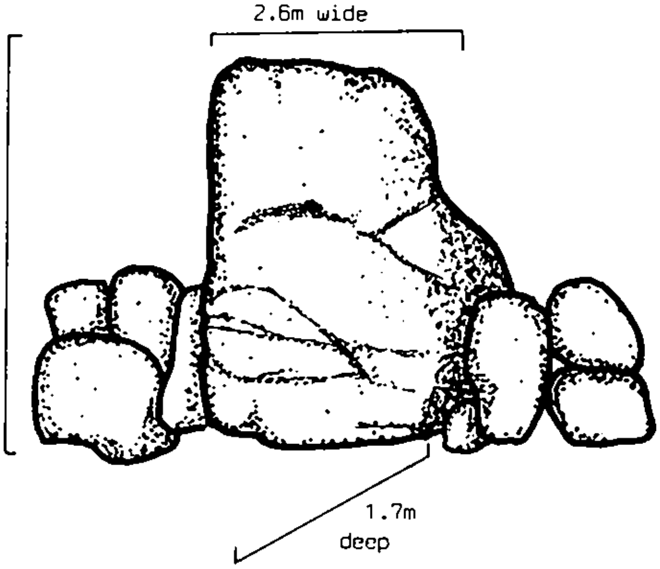


Figure 5. (top) View of Lower Boulder from Northwest.
(bottom) Drawing of Boulder Showing Maximal Dimensions.

Figure 6. Closeup Showing Anthropomorphic Character of Boulder.

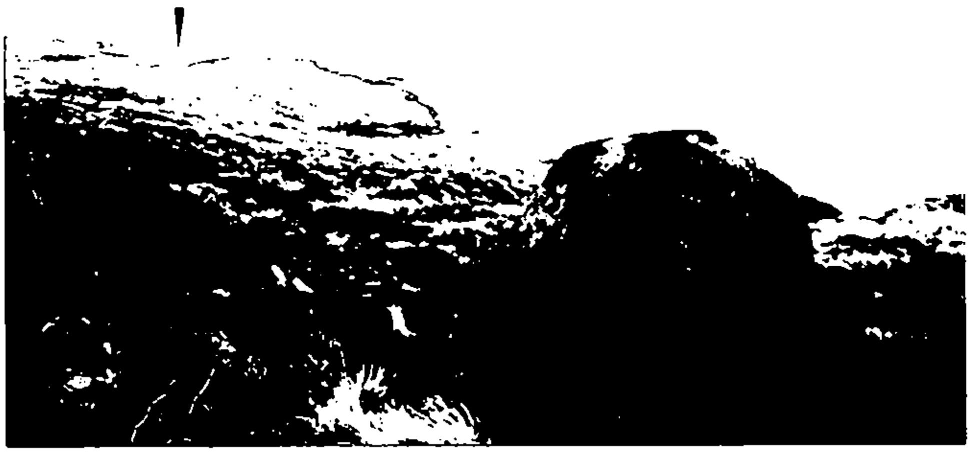


Figure 7. View North towards Hakiawa (arrow) from Lower Boulder Site.

RECOMMENDATIONS

Systematic surface collection and subsurface testing are recommended for Site 50-20-90-660 Feature A, based on the surface scatter of midden and artifacts present on and around the site. Also, Feature B, the other possible habitation structure should be investigated. The objectives of such an undertaking should minimally include:

1) determination of artifact types present,

2) analysis of midden samples,

3) recovery of datable material, and

4) determination of the nature and extent of subsurface deposition.

The recovery of pertinent data may aid in the functional interpretation for the individual features as well as the complex.

No further procedures are recommended at the lower boulder site. However, for both sites, every effort should be made to minimize direct and indirect impacts from human disturbance. Access to such sites need to be controlled and possibly restricted until more intensive archaeological investigations are completed.

Observations indicate that these sites are primarily affected by wind erosion rather than by water. Although no major damage or changes appear to have occurred during the 13 years since the 1980 survey, the recommended procedures should be implemented, as soon as possible, to ensure maximum data recovery.

ACKNOWLEDGEMENTS

Archaeoastronomy, especially in Hawaii, is a rather recent specialization that most archaeologists are not very familiar with. The current field trip and other similar cooperative ventures serve to demonstrate the value of such inter- and intra-disciplinary undertakings. The sharing of different ways of observing and interpreting cultural remains is a valuable and enriching experience for all involved. The knowledge of the existence of a complex and highly sophisticated traditional system of celestial observation together with an infrastructure of a network of manmade and natural features that served as observatories and reference points, will provide for the archaeologist another approach for the interpretation of site function.

The series of investigations and research conducted under the auspices of the Kaho'olawe Island Conveyance Commission brought together and fostered the sharing of knowledge, expertise, and interests among many individuals. Military personnel; physical, social, and natural scientists; *kupuna*; artists; government officials; and members of the Protect Kaho'olawe Ohana; were able to work in unison. Mahalo to the Commission for providing this opportunity.

I also wish to thank the following key individuals involved in logistics, planning, and administration; Hardy Spoehr, Roland Reeve, and Lt. Vernon Young.

The present value of Kaho'olawe is the absence of the rapid pace of change imminent in all of the other principal Hawaiian islands. In spite of being a target island for several decades, the many archaeological resources that still remain have existed with minimal historic and modern disturbances. Kaho'olawe provides an unmatched opportunity for comprehensive study. Perhaps as close to a "living laboratory" as scientists in Hawai'i may wish for. I hope that the individuals and agencies responsible for decisions regarding the future disposition of the island consider this aspect seriously.

REFERENCES

Hommon, Robert J.
1980 Kaho'olawe Site 660, National Register of Historic Places Inventory -- Nomination Form, April 1980.

Johnson, Rubellite Kawena
1993 *Preliminary Archaeoastronomical Inquiry into Some Kaho'olawe Sites Conducted in Field Excursions in March and September 1992 For the Kaho'olawe Conveyance Commission*, Consultant Report No. 9, Kaho'olawe Island Conveyance Commission, March 1993.

APPENDIX A:

National Register of Historic Places Inventory -- Nomination Form
Kaho'olawe Site 660

7 DESCRIPTION

CONDITION		CHECK ONE	CHECK ONE
__EXCELLENT	__DETERIORATED	__UNALTERED	__ORIGINAL SITE
__GOOD	__RUINS	__ALTERED	__MOVED DATE______
__FAIR	__UNEXPOSED		

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

Kaho'olawe archaeological site 660* is a complex consisting of three features (2 habitation enclosures and one cairn). The site is situated on a hill top overlooking the northeast coast at an elevation of about 232 meters (760 feet), about 800 meters from the coast. The vegetation consists of a moderate cover of various grasses. The site measures about 16 x 12 meters and includes about 192 square meters. Its boundaries were determined by the clustering of its constituent features and the absence of other sites for a distance of at least 100 meters in any direction.

Feature A

Feature A is an oval habitation enclosure measuring about 7.5 by 5.4 meters and standing to a height of 90 centimeters. The enclosure is constructed of multiple stacked pahoehoe chunks and boulders. The feature is in Ahupu Formation soil. The feature is situated on top of a hill and is partly covered with a moderate growth of various grasses. Surface midden is scarce and includes shells of thais (Thais aperta), and drupes (Drupa ricina). Also included are scarce amounts of porites (Porites sp.) coral. Surface artifactual materials include scarce amounts of basaltic glass flakes, and 1 broken adze blank. This feature is in fair condition and is currently being damaged by wind and surface water runoff. It is in need of immediate preservation action.

Feature B

Feature B is a round habitation enclosure measuring about 2.8 meters in diameter, and standing to a height of 50 centimeters. The enclosure is constructed of multiple-stacked pahoehoe chunks. An internal feature consists of a concentration of basalt flakes along the south wall measuring 3 by 2 meters. The feature is in Ahupu Formation soil. The feature is situated on top of a hill and is partly covered with a moderate growth of various grasses. Surface midden includes scarce amounts of thais (Thais aperta), and medium-sized cowries (Cypraea reticulata). This feature is in deteriorated condition and is currently being damaged by wind and surface water runoff. It is in need of immediate preservation action.

*Site 660 was discovered and recorded during a survey of Kaho'olawe conducted under the auspices of the United States Navy.

Form No 10-306 (Rev 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

FOR FEDERAL PROPERTIES

FOR NPS USE ONLY
RECEIVED
DATE ENTERED

SEE INSTRUCTIONS IN *HOW TO COMPLETE NATIONAL REGISTER FORMS*
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC

AND/OR COMMON
Kaho'olawe Site 660

2 LOCATION

STREET & NUMBER
Island of Kaho'olawe 9992 __NOT FOR PUBLICATION

CITY, TOWN
__ VICINITY OF
CONGRESSIONAL DISTRICT

STATE Hawaii CODE 15 COUNTY Maui CODE 009

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE	
__DISTRICT	X __PUBLIC	__OCCUPIED	__AGRICULTURE	__MUSEUM
__BUILDING(S)	__PRIVATE	X __UNOCCUPIED	__COMMERCIAL	__PARK
__STRUCTURE	__BOTH	__WORK IN PROGRESS	__EDUCATIONAL	__PRIVATE RESIDENCE
X __SITE	**PUBLIC ACQUISITION**	**ACCESSIBLE**	__ENTERTAINMENT	__RELIGIOUS
__OBJECT	__IN PROCESS	X __YES: RESTRICTED	__GOVERNMENT	__SCIENTIFIC
	__BEING CONSIDERED	__YES: UNRESTRICTED	__INDUSTRIAL	__TRANSPORTATION
		__NO	X __MILITARY	__OTHER

4 AGENCY

United States of America

REGIONAL HEADQUARTERS *(If applicable)*
Department of the Navy

STREET & NUMBER
Naval Air Station, Barber's Point

CITY, TOWN
__ VICINITY OF
STATE
Hawaii

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC.
Pacific Division

STREET & NUMBER
Naval Facilities Engineering Command

CITY, TOWN
Pearl Harbor
STATE
Hawaii 96860

6 REPRESENTATION IN EXISTING SURVEYS

TITLE

DATE
__FEDERAL __STATE __COUNTY __LOCAL

DEPOSITORY FOR SURVEY RECORDS

CITY, TOWN
STATE

8 SIGNIFICANCE

PERIOD	AREAS OF SIGNIFICANCE -- CHECK AND JUSTIFY BELOW			
_PREHISTORIC	_ARCHEOLOGY-PREHISTORIC	_COMMUNITY PLANNING	_LANDSCAPE ARCHITECTURE	_RELIGION
_1400-1499	_ARCHEOLOGY-HISTORIC	_CONSERVATION	_LAW	_SCIENCE
_1500-1599	_AGRICULTURE	_ECONOMICS	_LITERATURE	_SCULPTURE
_1600-1699	_ARCHITECTURE	_EDUCATION	_MILITARY	_SOCIAL/HUMANITARIAN
_1700-1799	_ART	_ENGINEERING	_MUSIC	_THEATER
_1800-1899	_COMMERCE	_EXPLORATION/SETTLEMENT	_PHILOSOPHY	_TRANSPORTATION
_1900-	_COMMUNICATIONS	_INDUSTRY	_POLITICS/GOVERNMENT	_OTHER (SPECIFY)
		_INVENTION		

SPECIFIC DATES BUILDER/ARCHITECT

STATEMENT OF SIGNIFICANCE

The significance of Kaho'olawe site 660 lies primarily in the data that it is likely to yield regarding the economic and residential patterns of the interior zone of Kaho'olawe, the history of settlement and population growth of the island as a whole, and the relationship between the coastal and inland zones.

Form No 10-300a
(Rev 10-74)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

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DATE ENTERED

CONTINUATION SHEET ITEM NUMBER 7 PAGE 2

Feature C

Feature C is an oval cairn measuring about 1.4 by 1.0 meters and standing to a height of 55 centimeters. The cairn is constructed of pahoehoe chunks and boulders. The feature is in Ahupu Formation soil. The feature is situated on top of a hill and is partly surrounded with a moderate growth of various grasses. Surface midden includes scarce amounts of thais (Thais aperta). This feature is in deteriorated condition and is currently being damaged by wind and surface water runoff. It is in need of immediate preservation action.

The form and contents of site 660 are evidence for a number of activities. The presence of scarce amounts of shell at features A, B and C indicates that the procurement preparation and consumption of food took place at or near these features. The presence of basaltic glass flakes, basalt flakes, and a broken adze blank at feature A indicates that basaltic glass and basalt artifacts were made at or near these features.

9 MAJOR BIBLIOGRAPHICAL REFERENCES

10 GEOGRAPHICAL DATA

ACREAGE OF NOMINATED PROPERTY .04

UTM REFERENCES

	ZONE	EASTING	NORTHING		ZONE	EASTING	NORTHING
A	0 4	7 5 4 8 0 0	2 2 7 8 1 7 0	B			
C				D			

VERBAL BOUNDARY DESCRIPTION

Kaho'olawe archaeological site 660 is located on a hilltop overlooking the northeast coast approximately 1300 meters south of Hakioawa beach, at an elevation of about 230 meters. See the enclosed contour map.

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE	CODE	COUNTY	CODE

11 FORM PREPARED BY

NAME / TITLE
Robert J. Hommon, Sr. Archaeologist

ORGANIZATION
Hawaii Marine Research, Inc.

DATE
April 1980

STREET & NUMBER
677 Ala Moana Blvd., Suite 200

TELEPHONE
537-4051

CITY OR TOWN
Honolulu, Hawaii 96813

STATE
Hawaii

12 CERTIFICATION OF NOMINATION

STATE HISTORIC PRESERVATION OFFICER RECOMMENDATION

YES____ NO____ NONE____

STATE HISTORIC PRESERVATION OFFICER SIGNATURE

In compliance with Executive Order 11593, I hereby nominate this property to the National Register, certifying that the State Historic Preservation Officer has been allowed 90 days in which to present the nomination to the State Review Board and to evaluate its significance. The evaluated level of significance is ____National ____State ____Local.

FEDERAL REPRESENTATIVE SIGNATURE

TITLE

DATE

FOR NPS USE ONLY

I HEREBY CERTIFY THAT THIS PROPERTY IS INCLUDED IN THE NATIONAL REGISTER

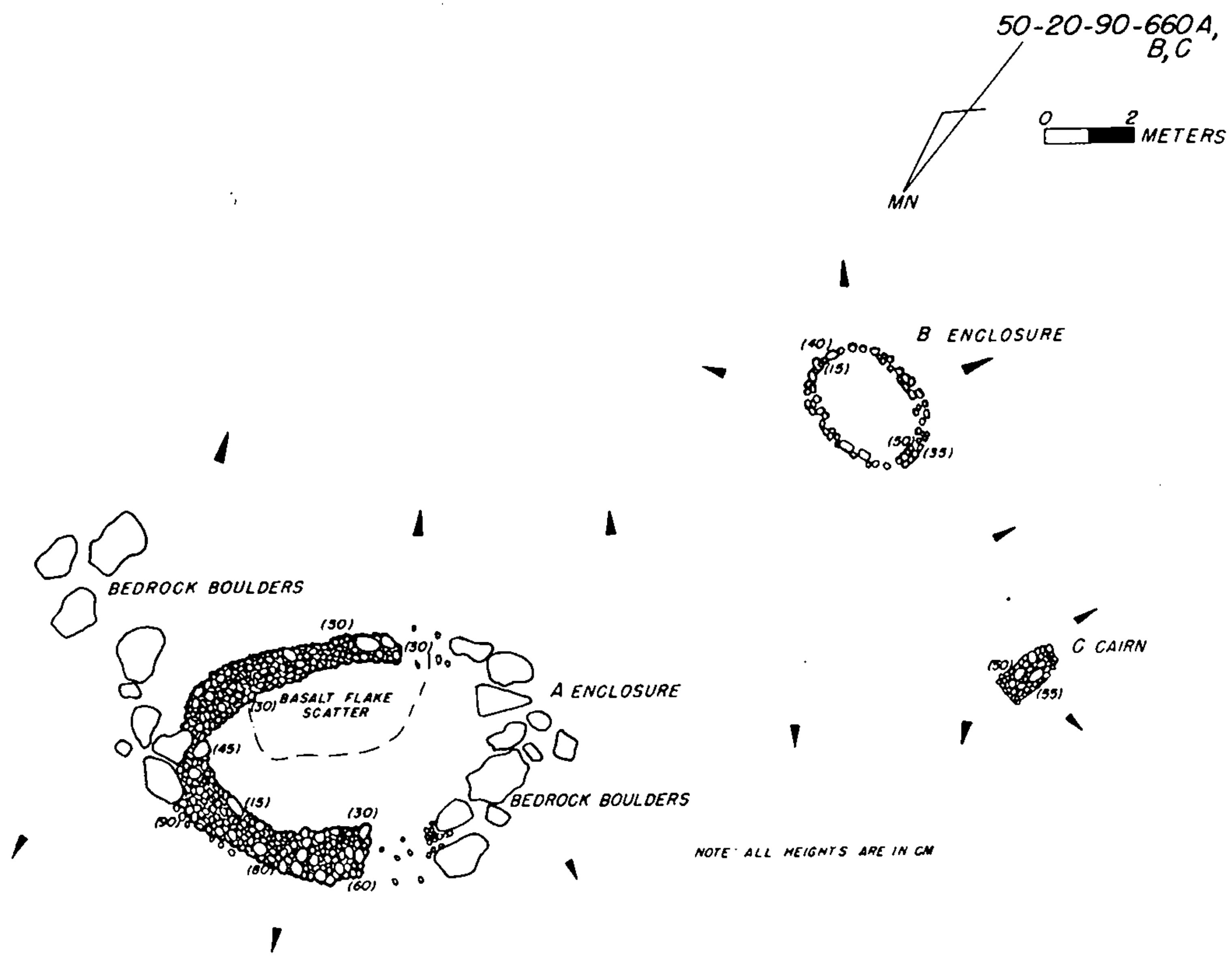
DATE

DIRECTOR, OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION

ATTEST:

DATE

KEEPER OF THE NATIONAL REGISTER


50-20-90-660 A, B, C
0 2 METERS
MN
B ENCLOSURE
(40)
(15)
(50)
(35)
BEDROCK BOULDERS
(30)
(30)
BASALT FLAKE SCATTER
(30)
A ENCLOSURE
(45)
(15)
(30)
(90)
(80)
(60)
BEDROCK BOULDERS
C CAIRN
(50)
(35)
NOTE: ALL HEIGHTS ARE IN CM