Rev. Mexicana Astron. Astrof., **19**, 47-53 (1989)

THE ARCHAEOASTRONOMY OF EASTER ISLAND (RAPA NUI)

William Liller

Instituto Isaac Newton
Ministerio de Educación de Chile

RESUMEN. Existe evidencia abundante que aproximadamente una docena de antiguos observatorios solares se localizan en Isla de Pascua. Además, hay varios petroglifos astronómicos y dos o tres punteros solares que muestran que la astronomía desempeño un papel muy importante en la vida de esta gente polinésica aislada.

ABSTRACT. There exists abundant evidence that roughly a dozen ancient solar observatories are located on Easter Island. Furthermore, there are a number of astronomical petroglyphs and two or three solar pointing devices that show that astronomy played a very important role in the life of these isolated Polynesian people.

Key words: **ARCHAEOASTRONOMY**

I. INTRODUCTION

Much has been written about observatories in ancient Egypt, stone-age Britain, and the cultures of Maya and Inca, but little has been said about possible astronomical structures in Polynesia and especially Easter Island (Rapa Nui). The Polynesians who were criss-crossing the Pacific Ocean a millenium before Columbus dared make a voyage across the Atlantic obviously had highly developed navigational skills. Did they build devices or monuments on land to observe positions of astronomical objects or to point towards solstices and equinoxes? If so, where are they? And if so, how accurate were these island observatories? To what level of sophistication were the Polynesians able to rise in their understanding of the complex relative motions of the sun and moon?

Edwards (1989) reports that in the Society Islands, a small proportion of the many *marae* seem to be intentionally oriented with either the solstitial or equinoctial rising points. On Tonga the famous trilathon, *Ha'amonga-a-Maui*, is said to be aligned with the equinoxes (Bellwood 1987), and in Hawai'i a number of religious structures are oriented east-west (Valeri 1985). Buck (1938) writes that on Mangareva the winter solstice was noted when the shadow of Mount Duff failed to pass a certain stone. However, findings such as these hardly suggest a highly developed use or knowledge of astronomy.

Perhaps the early islanders were concerned only with the directions in which the famous Easter Island statues, the *moai*, looked. One can readily imagine the astronomer-priests wanting to have these images of departed chieftains oriented so that they stared directly at the rising sun on the longest or shortest day of the year or the date of the spring equinox. Or possibly special monuments served as calendar markers so that important fiestas or anniversaries, or planting times or fishing seasons could be remembered and noted. If the orientations were good to a degree or two -- or less -- then the conclusion would have to be that the early *rapanui* not only knew rather precisely where the sun rose on critical dates, but also had a special interest in marking these directions. With our modern day inventions -- radio, television, digital watches -- we are continually reminded of the date, but a thousand years ago on the most remote island in the world, one had to rely on the sun and the stars.

The most imposing structures on Rapa Nui are the ceremonial platforms, or *ahu*. Over three hundred of them, varying in length from a few meters to almost 150 meters, are now

known, and approximately 90 per cent of them are located within 500 meters of the rugged shoreline. The earliest ones probably date from the first years of the island's occupation. Many, but not all, of the *ahu* were intended to support one or more *moai* that would look protectively inland towards a nearly settlement. At one time at least fifteen *moai* stood on the longest and grandest *ahu*, Tongariki. However, during the internal wars that began late in the 17th century, all the *moai* were toppled. By 1850 none remained standing.

This report will be concerned solely with Rapa Nui and almost exclusively with the *ahu* and the identification of possible solar observatories. The writer hopes, in the near future, to consider other aspects of archaeoastronomy, both on Rapa Nui and on other Polynesian islands.

II. FIRST DISCOVERIES

Probably the first person to make note of astronomical sites was Katherine Routledge (1919). A flat rock on the Poike Peninsula, *papa ui hetu'u*, and a cave just north of Hangaroa, *ana ui hetu'u*, were, she was told, places for "watching the stars" and where astronomer-priests taught their apprentices the strange ways of the cosmos. (See Figure 1.)

However, the first objective investigations of possible observing devices and structures were made by members of the 1955-56 Norwegian Archaeological Expedition (Heyerdahl and Ferdon 1961). The three most noteworthy findings were (1) a group of four cavities cut into bedrock at Orongo; (2) the orientations of two stone platforms at Tepeu; and (3) the orientations of the two great *ahu* at Vinapu. Their results can be summarized as follows:

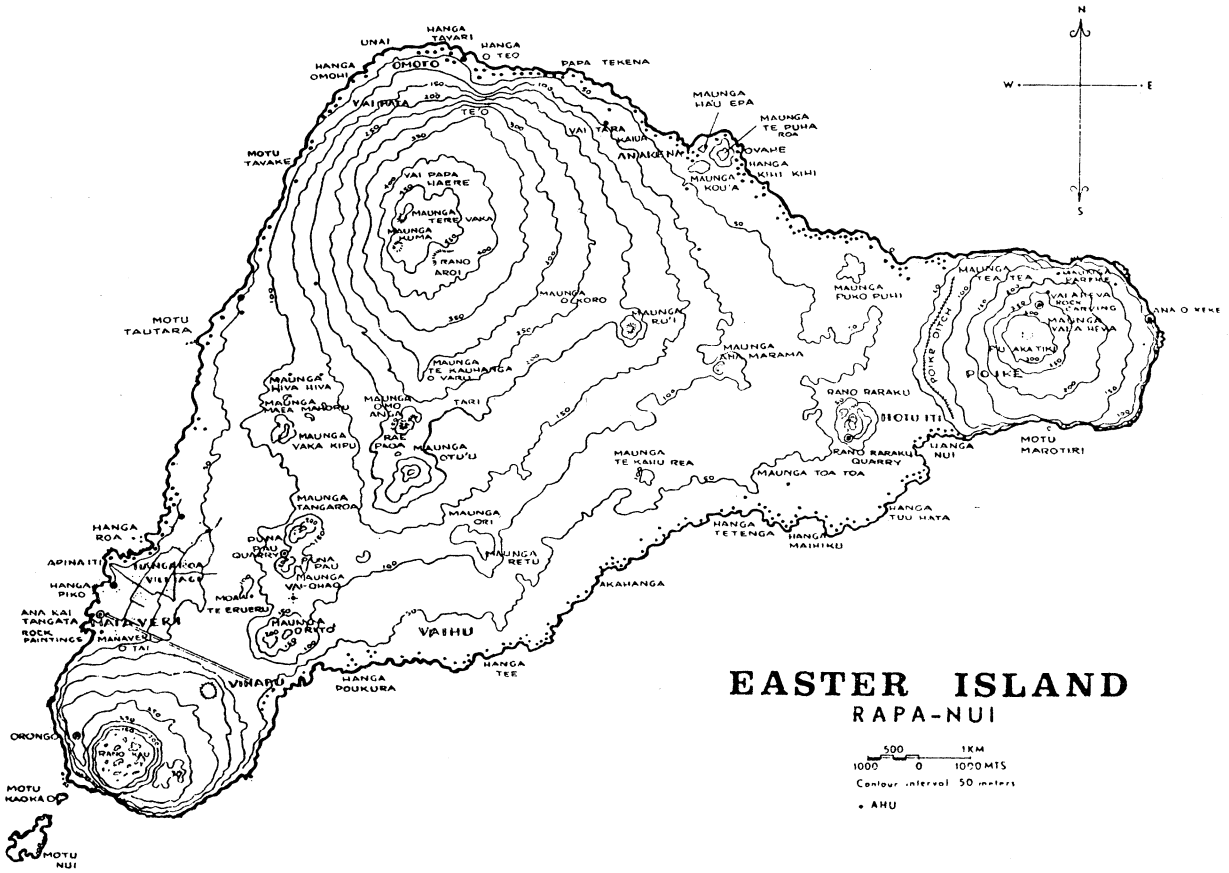

Fig. 1. Map of Easter Island.

In his survey of the important ancient village of Orongo, Edwin Ferdon (1961) noted a curious group of four depressions, three obviously man-made, cut into a rounded remnant of exfoliating bedrock beside "Structure 1", thought to be a very early *ahu*, or ceremonial platform. From his observations, Ferdon deduced that they had been positioned to point towards the directions of the rising sun at times of solstices and the equinoxes, and consequently he called them "sun stones".

In a study of a group of representative *ahu*, Carlyle Smith (1961) discovered that the two central platforms at Tepeu, a few kilometers north of Hangaroa, were oriented so that the eight *moai* that once were mounted there faced directly at the rising sun on the longest day of the year, the date of the summer solstice.

William Mulloy (1961) carried out a detailed archaeological survey at Vinapu and found that a perpendicular to the seaward facade of the magnificent *ahu* called Vinapu 1 pointed in the direction of the rising summer solstice, and a similar perpendicular for Vinapu 2 was aimed at the equinoctial rising point.

Mulloy later returned to the island a number of times and found other structures that appeared to be intentionally oriented with the critical sunrise or sunset direction. One of the better known is the inland Ahu A Kivi with its seven *moai* re-erected by Mulloy himself together with his Chilean colleague and close friend Gonzalo Figueroa (Mulloy and Figueroa). They discovered that the *ahu* had been built with the *moai* facing nearly due west. Also, a second *ahu*, Vai Teka, was located almost due west of A Kivi 800 meters away. Mulloy and Figueroa suggested that these alignments were intentional and astronomically inspired.

It is important to note that nearly all of these investigations were made using magnetic compasses (with the difference in direction between magnetic north and astronomical north properly corrected for). However, as the Chilean Armada map clearly warns, sizeable magnetic anomalies exist on the island, and one has to ask if some of the measurements were erroneous.

Realizing this, Mulloy decided, in 1965, to make a systematic survey of the orientations of all known coastal *ahu* with optical surveying instruments using the direction of the rising and setting sun to establish an accurate frame of reference. During more than two months, Mulloy and two assistants went from *ahu* to *ahu* around the coast of Rapa Nui measuring their precise orientations (see Mulloy *et al.* 1989). Some 272 sites were visited and some described for the first time. His results produced few surprises: over ninety per cent of these coastal *ahu* were oriented with their long sides closely parallel to the adjacent shoreline. Thus it appeared that no more than a handful of these could have been intentionally oriented towards astronomical directions.

III. RECENT INVESTIGATIONS

In 1986 as a part of a NASA project, the author established a small observatory on Rapa Nui to observe Halley's Comet (Liller 1987). During his three-month stay there, he collaborated with archaeologist Dr. Georgia Lee and carefully checked the pointing directions indicated by the Orongo "sun stones". Noting the discovery, by Dr. Frank Morin (1986), that local rocks near the site were strongly magnetized, Lee and Liller relied totally on photographs and theodolite sightings of stars to establish true astronomical directions. Their findings were that the directions claimed by Ferdon were incorrect, and that the alignments were, for some reason, as much as 16 degrees from the critical solar directions (Lee and Liller 1987). Their conclusion: these four depressions must have served some other purpose.

Similar measurements by the author (Liller 1989a) at the A Kivi-Vai Teka complex revealed difficulties with the suggested interpretations of Mulloy and Figueroa. The line connecting the two *ahu* is oriented 5.9 degrees from the east-west direction, and the seven *moai* face not due west, but 3.2 degrees to the south of this bearing. The size of these deviations indicates either that the foundations of these structures were poorly laid out, or that there never was any astronomical intent.

Both Mulloy and the writer independently re-measured the orientations of the two platforms at Tepeu and the two at Vinapu and confirmed that they were in fact oriented rather

closely -- within a degree -- to the suggested directions. However, both sites are located near the coast, and as was the usual custom, the platforms were built with their long axes closely parallel to the shoreline. As it happens, at both locations, the shoreline is solstitially aligned. If these *ahu* had been intended to be used astronomically, it will be impossible to prove it without further revelations.

Another *ahu* investigated and carefully restored by Mulloy (1975) together with Sergio Rapu Haoa is Huri A Urenga. See Figure 2. Situated between Maunga Orito and Puna Pau 1.5 kilometers from the nearest shore , it has a single *moai* standing on a platform at the west end of an enclosed plaza. Mulloy noted a curious orientation of the platform: it was skewed some 20 degrees to the overall plan of the plaza, a design feature not known to exist (at that time) anywhere else. Mulloy's conclusion was that this strange design resulted because the *ahu* builders intended to have the *moai* face the direction of the rising sun on the date of the winter solstice. According to his compass measurements, a perpendicular to the platform pointed to within a degree of this critical direction.

Fig. 2. The *moai* at Ahu Huri A Urenga.

In 1986 the writer and Chilean meteorologist, Julio Duarte D. remeasured this orientation optically and confirmed Mulloy's result (Liller and Duarte 1986). In addition, they noted that 1.5 kilometers away and in this same solstitial direction was a small, sharply-pointed hill known as Maunga Mataengo. At its summit was a cave clearly visible from Ahu Huri A Urenga. On the morning when the sun reached the winter solstice, sunrise would have occurred directly behind the peak of this hill. Liller and Duarte also found another prominent hill, Maunga Tararaina located 1.0 kilometers towards the west; its summit was within a degree of the direction of the setting equinoctial sun. (Much of this hill was removed in 1987 to provide landfill for the recent airport extension, but fortunately Liller and Duarte were able to measure its azimuth as seen from Huri A Urenga. Also, its location is accurately recorded on several topographical maps, including the Atlas Arqueologico de Isla de Pascua (Cristino *et al.* 1981).)

Other intriguing findings were made: Due east of Ahu Huri A Urenga lies another *ahu* with a single *moai*, Ahu Ko Te Pei, and again in the west were two other *ahu*, A Kava and Piki Rangi. One more *ahu* with no known name lies in the direction of the setting summer solstice sun. All these coincidences -- four *ahu* and two *maunga* -- are within two degrees of the indicated directions. One has to suspect strongly that the *ahu* were intentionally placed to provide sightlines to the rising and setting solstitial and equinoctial sun.

But perhaps Mulloy's most convincing discovery is the following: Beside the plaza at Ahu Huri A Urenga, he uncovered a set of five man-made depressions pecked into the bedrock. Mulloy's compass readings hinted at an astronomical useage, and the writer and Duarte have since solidified this conclusion: Four different pairs of these five cavities pointed closely -- three to better than a degree -- to the three significant solar rising points plus due north. The line connecting a fifth pair of depressions paralleled the plaza wall to within a fraction of a degree.

Thus, a total of ten indicated directions are oriented closely with key solar rising and setting azimuiths and the north-south direction. There can be little doubt that Ahu Huri A Urenga served as a solar observatory and was constructed with an impressively high level of sophistication.

Are there other *ahu*-observatories? Almost certainly. The "three most outstanding monuments" on the island, according to Englert (1974), are massive Ahu Hekii on the north coast, Ahu Tongariki with its fifteen *moai*, and the well-known Ahu Vinapu. Five central

platforms are involved, and *all five* are oriented so that facade perpendiculars point closely towards either a rising solstice or equinox. Four are within 3.0 degrees, and the fifth, Tongariki misses by only 5.5 degrees (average of differences = +2.0 degrees). Furthermore, one of the Hekii platforms is, much like at Huri A Urenga, skewed (by 13 degrees) to the larger underlying structure. If one calculates from Poisson statistics the probability of having by chance all five platforms aligned astronomically, one finds that the probability is, at most, one in a thousand; and with one *ahu* specially skewed, the astronomical intent must be considered even more convincing. Thus, it seems highly probable that the three most magnificent *ahu* were designed to have solstitial or equinoctial orientations.

There is other, even stronger statistical evidence for the existence of ancient astronomical structures. If one considers the 272 coastal *ahu* visited by Mulloy and selects from these only those few (23) that are not (within 20 degrees) parallel to the neighboring shoreline, one finds that almost half -- eleven -- are oriented such that perpendiculars to their facades pass within 3 degrees of the critical solar directions. See Figure 3. Poisson statistics tell us that the probability of finding six or more *ahu* in any given 3 degree bin is 0.0000051, or about one chance in 200,000 (Liller 1989b). Conclusion: some of these *ahu* -- perhaps eight or ten -- were intentionally designed to be aligned with critical solar directions.

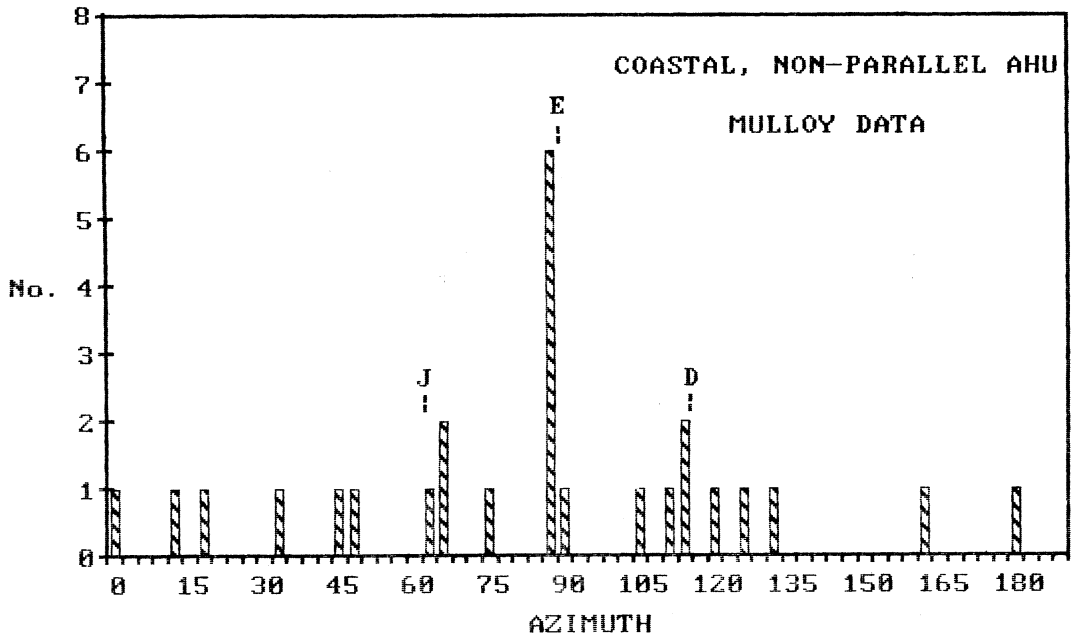

Fig. 3. Orientations of the perpendiculars to 25 facades, walls, or long axes of 23 *ahu* located within 500 meters of the coast and with major axes skewed by more than 20 degrees to the adjacent shoreline. Letters J, D and E indicate the rising azimuths of the two solstices and the equinoxes.

Table 1 lists these eleven *ahu* and gives the azimuths of the perpendicular (A_{PERP}) to the noted features. Note that if the *ahu* number is preceeded by the letter E, then the *ahu* is listed in the inventory of Englert (1974). M-numbers correspond to the listing in Mulloy's survey (see Mulloy *et al.* 1989), and locations of these *ahu* are indicated in the table. Exactly which of these eleven platforms were intentionally oriented astronomically may be impossible to know for certain. It would seem that Hekii 2 (E107), with its platform skewed to the overall plan of the site, is the best candidate and warrants more study. The central

axis of the beautifully preserved Ahu A Tanga (E51) located near the north tip of Rapa Nui points to within a few tenths of a degree of due north, and a detailed investigation of this structure should also be carried out.

TABLE 1. Coastal *Ahu* Not Paralleling the Shore and Solstitially or Equinoctially Oriented

No.	Name	A_{PERP}	Measured Feature	Length (meters)	Remarks
E5	Makere	64.2°	Facade	31	Sunrise at 2.5° alt.
M245		89.7	W. facade	6	N. end Hanga Pico Bay.
E51	A Tanga	89.7	Axis	26	*Poe-poe** in exc. condition.
E60		116.5	Facade	12	May be a *hare moa***.
E61		90.6, 88.1	Platform, N. facade	50	Complicated form. Very probably two *ahu*.
E106	Hekii 1	68.5, 66.3	Old facade, New facade	88	Massive construction, 5m high. At least 6 moai.
E107	Hekii 2	88.7, 76.0	Platform, E. Facade	35	20m in front of facade of Hekii 1. Four moai.
E124	Te Pupuhi?	88.6	Facade	33	Much destroyed. Mulloy: may have been a *poe-poe**.
E150	Huri Avai	116.5	E. facade	8	Said to be a royal tomb.
M265	Ruru O Ao	89.8	E. facade	32	100m N of E188. One moai.

* A *poe-poe*: An unusual type of *ahu* having a general appearance similar to a Polynesian canoe (*poe-poe* means "flat-bottomed boat").

** Evidently, because chickens were of such considerable value, their houses, called *hare moa*, were built like small fortresses.

Two *ahu* have names which include the *rapanui* word *ra'a* meaning sun: Ra'ai and Rua Tau Ra'a. (According to linguist Cynthia Rapu, *Ra'ai* could be a variant spelling of the word.) Several years ago Malcolm Clark (1984) independently pointed out that as seen from Ahu Ra'ai, the sun would rise over the crater at Poike's Peak (where the evil eclipse god, Katiki was supposed to have lived) and set behind Maunga Pui. Recent measurements by the writer have now fully confirmed Clark's observations.

Katiki's lair at the summit of Poike must have played an important role as a calendar indicator as seen from the important socio-religious center at Orongo. As seen from Ferdon's Structure 1, the winter solstice sun would have risen a scant 0.6 degrees to the left of this imposing peak with central tree-filled crater. As has been said elsewhere, the natives must have considered this coincidence as god-given (Lee and Liller 1987).

One coastal *ahu* southwest of Rano Raraku, Puna Kape, has an interesting structure attached to it pointing inland. It appears to be a raised walkway 47 meters long and 2 meters wide; near its center stands the headless torso of a *moai*, and a red scoria topknot a few meters away. Mulloy suggested that this structure might be a separate *ahu*. Whatever its purpose, its long axis points just 1.0 degrees to the left of due north (Liller 1989b). Could it have been used as a kind of navigational beacon by islanders in boats offshore?

In total, there would seem to be perhaps as many as a dozen *ahu* which show clear evidence of having been designed to be used as a solar pointing device. Now needed are careful archaeological studies to confirm these conclusions and to learn more about their manner of useage.

Were there observatories for other astronomical bodies? Besides the moon and the brighter planets, the Pleiades, the Belt of Orion ("Las Tres Marias"), and Antares were important to the Polynesians (Johnson and Mahelona 1975). One *ahu* contains the name of the planet Mars; another has the *rapanui* name for Antares. But except for these tantalizing curiosities, we have no indications of the useage of such structures.

Finally, in support of the concept that astronomy played an important role in the life of early Easter Islanders it is noteworthy that petroglyph expert Dr. Georgia Lee (1986) has found a number of interesting rock carvings which seem to show astronomical objects -- comets, lunar crescents, stars, and constellation patterns. Many years ago Kathryn Routledge desribed a rock about 200 yards from *papa ui hetu'u* on which constellation figures had been pecked (Routledge 1919). Obviously, the heavens were an important part of the life and lore of the early islanders. Lee and the writer have been told of the existence of other "constellation stones", not yet found.

In summary, Ahu Huri A Urenga shows virtually irrefutable evidence of having been designed to be a solar observatory, and it, along with Britain's *Stonehenge*, the Mayan *El Caracól*, and the Incan *Templo del Sol*, must be considered as a monument to the intelligence of stone-age man. Other solar observatories almost certainly existed, very possibly the great *ahu* of Tongariki, Hekii, and Vinapu, and perhaps eight or ten others scattered over the island.

The writer wishes to thank Dr. Georgia Lee for her encouragement and assistance, Don Sergio Rapu Haoa for his help and enthusiasm, and Don Gonzalo Alcaino, Director of the Instituto Isaac Newton who continually provides support. Finally, my wife, Matty, working with me tirelessly both in the field and by the computer, has been, in a word, indispensable.

REFERENCES

Bellwood, P., 1987. *The Polynesians* (Thames and Hudson: London), p. 69.
Buck, P.H., 1938. *The ethnology of Mangareva*. Bernice P. Bishop Museum Bulletin No. 157.
Clark, Malcolm A., 1984. "Sun, moon, and volcanoes on Easter Island", a presentation at the *International Congress on Easter Island and Eastern Polynesia*.
Cristino, C., Vargas, P., and Izaurieta, R., 1981. *Atlas Arqueológico de Isla de Pascua* (Corporación Toesca, Santiago, Chile).
Edwards, E., 1989. Private communication.
Englert, S., 1974. *La Tierra de Hotu Matu'a: Historia y etnología de la Isla de Pascua*. (Ediciones de la Univ. de Chile, Santiago).
Ferdon, E., 1961. In Heyerdahl and Ferdon 1961 (*op.cit.*), p.228.
Heyerdahl, T. and Ferdon, E.N., Jr., 1961. *Archaeology of Easter Island* (School of American Research and Museum of New Mexico, Santa Fe).
Johnson, R.K. and Mahelona, J.K., 1975. *Na Inoa Hoku. A catalogue of Hawaiian and Polynesian star names* (Topgallant Publ. Co., Honolulu).
Lee, Georgia, 1986. *Easter Island Rock Art: Ideological symbols as evidence of socio-political change*. Ph.D. Dissertation, Univ. Cal. Los Angeles.
Lee, G., and Liller, W., 1987. *J. Polynesian Society*, 96, 81. See also *Archaeoastronomy*, Suppl.to the J. History Astronomy, No. 11, S1.
Liller, W., 1987. *Mercury*, 16, 130.
Liller, W., 1989a. "*Hetu'u Rapanui*: The archaeoastronomy of Easter Island", to appear in *From Asteroids to Quasars* (Cambridge University Press).
Liller, W., 1989b. Submitted to *Archaeoastronomy*, Suppl.to the J. Hist. Astronomy.
Liller, W. and Duarte, J. 1986. *Archaeoastronomy*, 9, 38.
Morin, F. 1986. Private communication.
Mulloy, W., 1961. In Heyerdahl and Ferdon 1961 (*op.cit.*), p.94.
Mulloy, W., 1975. *Archaeo. and Phys. Anthro. in Oceania*, 10, 1.
Mulloy, W. and Figueroa, G., 1978. *Asian and Pacific Archaeology Series*, No.8 (University Press of Hawaii, Honolulu).
Mulloy, W., Liller, W., and Lee, G., 1988. "A survey of *ahu* orientations around the coast of Easter Island". In preparation. Also available from the author in PC-readable form.
Routledge, K.S., 1919. *The mystery of Easter Island* (Hazell, Watson, and Viney: London).
Smith, C., 1961. In Heyerdahl and Ferdon 1961 (*op.cit.*), p.189.
Valeri, V., 1985. *Kinship and sacrifice: Ritual and society in ancient Hawai'i* (U. Chicago).

William Liller: Instituto Isaac Newton, Casilla 437, Viña del Mar, Chile.