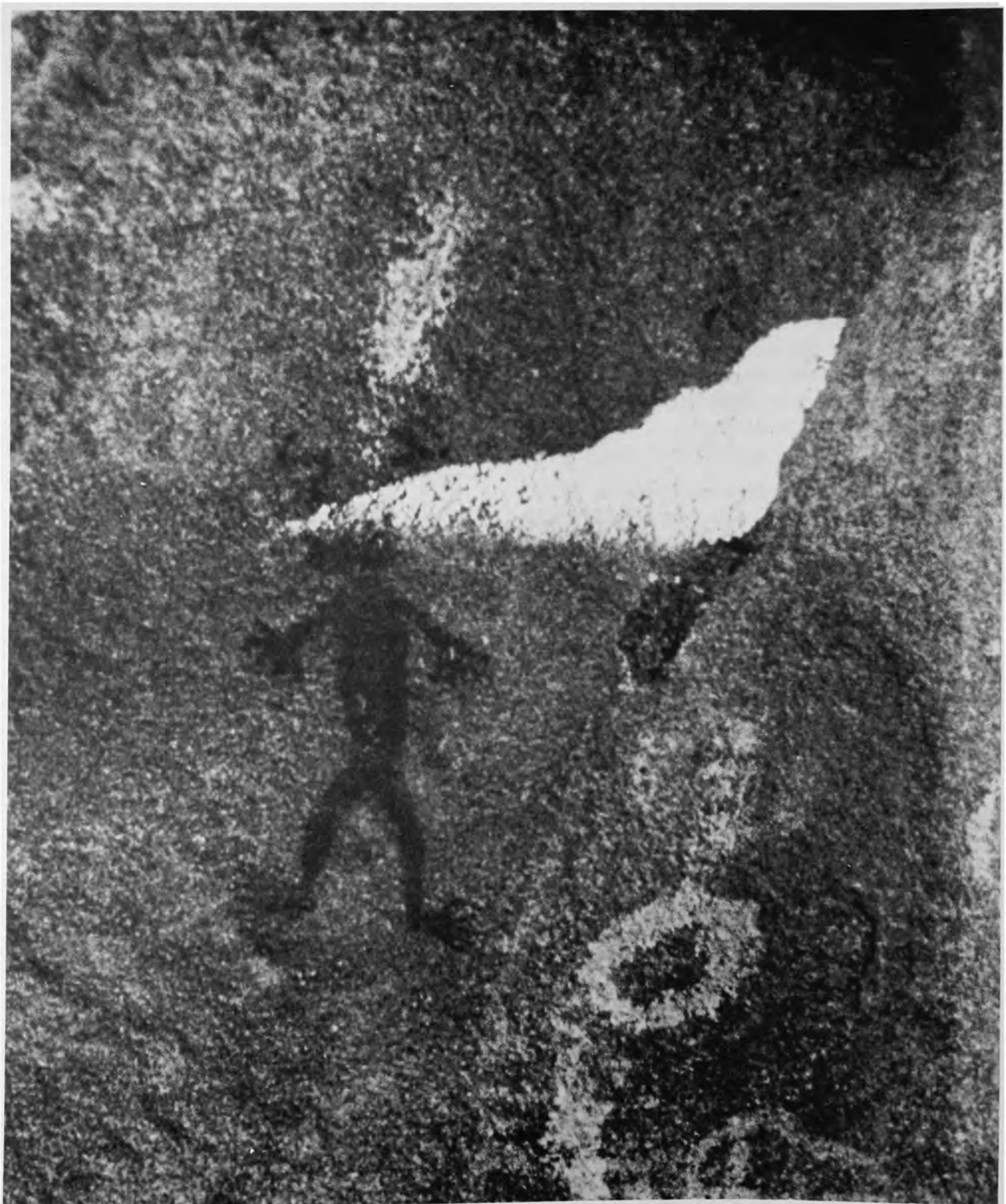

Light striking the eyes of an anthropomorphic figure on the wall of La Rumorosa rockshelter in Baja California. The event takes place during sunrise on the winter solstice (photograph by Ken Hedges).

Solstice Observers and Observatories in Native California

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FOR most of native California, there can be little doubt that the inhabitants considered the sun, moon, stars, and visibly bright planets with more than passing interest. Everywhere celestial objects were mentioned in myths and songs, and at least in the southern portions of the state they were accorded additional meaning in ritual and art. Indeed, astronomical knowledge was expressed in many ways, such as in the origins and exploits of various First (Sky) People, or in calendar form to regulate sacred timing of ceremonial, legal, economic, political, or social affairs (Hudson and Underhay 1978; Hudson 1978a).

Of importance too was the occurrence of unexpected celestial phenomena, such as a meteor shower, the appearance, motion, and dynamic physical changes of a visiting comet, or a spectacular solar or lunar eclipse. Such events only served to underscore a native world view that powerful supernatural forces above were at work in the cosmos, and the responses they inspired were ones of prayers, prophecies, and displays of supernatural power (Bean 1976:415). At least among the Chumash, they seem also to have inspired men to depict such events upon the walls of caves (Hudson and Underhay 1978:71-72, 99). Elsewhere, one researcher has postulated depictions of sidereal lunations, solstice markers, and perhaps even the Great Supernova of A.D. 1054 in east-central California rock art (Mayer 1977), while depictions of celestial objects (sun, moon, stars, Milky Way) are known in southern California sandpaintings (Kroeber 1925:662-663). Even the Island Gabrielino are mentioned as representing such objects (sun and moon); during the 1602 visit of Sebastián Vizcaíno to Santa Catalina, he observed these figures painted on the floor of a "Sun Temple" (Burney 1806:248-249; Bolton 1925:85).

In this paper, it is our purpose to focus upon one of these celestial objects, the sun, particularly in terms of solstitial observations. We will examine the importance of solar observations among Native Californians, and describe the techniques used to determine the solstice. We will also describe archaeoastronomical sites and explore ideas for locating others. Because the subject is so new in California research, our conclusions must by necessity be general ones and, of course, subject to change with new data.

IMPORTANCE OF THE SUN AND SOLSTICE

In portions of central and southern California, there appears to have been a pantheon composed of five conspicuously bright celestial objects—sun, moon, Polaris (North Star), and Venus in both aspects as Evening and Morning stars (Hudson and Blackburn 1978). The dynamic composition of these objects, as they changed position or became invisible through the course of the year, was held to mirror the ever present possibilities of a cosmic imbalance. To maintain a balanced universe, it was necessary to carefully watch and interpret celestial changes, and by the use of supernatural power to manipulate them for the benefit of society (Bean 1976). Observational astronomy was necessary to ritually cope with the natural environment.

Basic to this behavior was the belief that celestial objects were deities whose attributes and powers were understandable, predictable, and similar to those of man. As outdoor people, Native Californians were well attuned to closely watching rhythmical cycles of nature around them. These people realized that earth's natural changes were directly related to celestial changes taking place above them. Although they did not come to theorize that the earth's seasonal changes were produced by its axial tilt and revolution around the sun, they understood that when the sun could be seen rising or setting at a certain location on the horizon, or when certain stars appeared in a dawn or twilight sky, certain seasonal changes were about to take place on earth: rain would come, leaves would dry, seeds would ripen, deer would migrate, and so forth. In short, they perceived a cosmos in which seasonal changes on earth were caused by cosmic forces above, and it was this basic concept that no doubt transformed celestial object into celestial deity. The magnitude of these changes, produced by untouchable and distant objects, supported the conclusion that these celestial deities were immensely powerful.

Of the many conspicuously bright and large celestial objects transformed into supernaturals, none was so dramatic or considered more important than the sun. Everywhere in the state there was more than a general awareness of the interconnection between the sun's movements and the earth's seasons. In the central and southern portions of the state where a Mediterranean climate prevails this association took on a very conspicuous "life or death" theme. At the time of the winter solstice (December 21-22), the days are cool and short, and mark the approximate beginning of the rainy season. The summer solstice (June 21-22) mirrored the complete opposite, with long, hot days and the approximate beginning of drought. It was only reasonable that to Native Californians the Sun was an immensely powerful being: bringer of rain or drought, light or darkness, warmth or cold. Indeed, Sun had powers of life or death over the entire biotic world of which man was a part, and he could be manipulated by prayers, ceremonies, and rock paintings (Bean 1976; Hudson and Underhay 1978:56-57). Even daily prayers to Sun were made as he rose, according to Chumash consultant María Solares (Harrington n.d.).

The critical times for man or earth were the solstices, the two solar extremes of Sun's travels; should Sun decide not to take up his journey, it meant a cosmic imbalance and death for all. Supernatural intervention on the part of shaman-priests was needed to "encourage" or "pull" Sun back again; a similar belief occurs among Southwest Pueblo peoples (Ellis 1975:63). Solstitial ceremonies were important for the continuance of life, and among the Chumash these major ritual events were conducted by leaders holding the title of "Image of the Sun" and "Splendor of the Sun" (Hudson *et al.* 1977:57). Such ceremonies marked the time when offerings were given at shrines, mourning ceremonies for the soul's journey to the land of the dead were performed, and at least some rock art was executed (Hudson and Underhay 1978:51-73).

Similar solstitial beliefs appear elsewhere in California, such as among the Gabrielino (among whom some ritual leaders held the title "Sun"), Fernandeño, Kitanemuk, Salinan, Costanoan, and Tipai (Bolton

1931:251; Harrington 1942:29, item 1124; Blackburn and Bean 1978:568; Broadbent 1972:74-75; Johnson 1914:24-25; Heizer 1968:38-39, 119). A Luiseño neophyte named Pablo Tac (1952:94) stated that his people adored the sun god, and a Franciscan priest stationed among them recorded the importance of their solar rituals:

> They celebrated with more pomp and attention the sun's arrival at the Tropic of Capricorn [winter] than for [the] Tropic of Cancer [summer], for they were pleased with the sun's approach toward them. Its return meant much to them for it ripened their fruits and seeds, gave warmth to the atmosphere, and enlivened again the fields with beauty and productivity [Boscana 1933:65-66].

Concerning the Costanoan living near Mission San Jose, another Franciscan priest wrote:

> . . . They adored the sun when it receded towards the south pole. They thought it was angry and they held dances in its honor and offered it seeds, etc., until they knew it was about to return to them [Geiger and Meighan 1976:92].

Obviously, the solstices were times of great ritual importance in southern and central-coastal California, but the events did not go unnoticed elsewhere, particularly the winter solstice: the Monache performed a general curing ceremony about this time of year (Gayton 1948:267), the Kawaiisu observed it with group drinking of *Datura* (Driver 1937:86, items 1270-1271), and the Klamath found it an ideal time for their shamans to exercise and exhibit supernatural powers (Spier 1930:240). In much of northern California, the event was tied also into the calendar (discussed below).

Table 1
A SURVEY OF SOLSTITIAL OBSERVATIONS AMONG NATIVE CALIFORNIANS AS REPORTED IN THE ETHNOGRAPHIC LITERATURE
(Abbreviations: W, winter solstice; S, summer solstice; B, both solstices; D, direct observations; I, indirect observations; B, both direct and indirect observations)

Tribe	Solstices Observed	Observation Method	References and Notes
Tolowa	W	?	Barnett (1937:176, items 849-850); Drucker (1937b:240). Year began in calendar when sun was farthest south.
Yurok	W	?	Kroeber (1922:322); Driver (1939:342, item 1578).
Karok	W	?	Driver (1939:342, item 1578); Bright (1978:188).
Hupa	W	?	Driver (1939:342, item 1578).
Chilula	W	?	Driver (1939:342, item 1578).
Cahto (Kato)	B (?)	?	Driver (1939:342, item 1578, and note, p. 401). No data, but consultant certain there were names for the solstices.
Yuki	?	?	Driver (1939:342, item 1578). No data.
Nongatl	?	?	Driver (1939:342, item 1578). Probably did not observe solstices.
Chimariko	?	?	Driver (1939:342, item 1578). No data.
Wiyot	W (?)	D	Driver (1939:342, item 1578, and note, p. 400). Head doctor or chief kept track of seasons by watching location of rising and setting sun on horizon.
Sinkyone	?	?	Driver (1939:342, item 1578). No data.
Shasta	B	B	Voegelin (1942:143, items 4436-4453, and note, p. 234); Holt (1946:341). Had marks for sun in large assembly house. Made notches on floor near fireplace or on center post of ceremonial lodge. Also marks on trees to watch where sunlight struck to determine solstices.

Table 1 (cont'd.)

Tribe	Solstices Observed	Observation Method	References and Notes
Klamath	B	B	Spier (1930:219-220); Voegelin (1942:143, items 4437-4453). Solstices determined by marks in structure and by sun in relationship to mountains and trees. Calendar began with winter solstice.
Modoc	B	B	Kroeber (1922:323); Voegelin (1942:143, items 4436-4453). Same as Klamath.
Achumawi	B (?)	B	Voegelin (1942:143, items 4436-4453, and note, p. 234). Watched where sun rose on shortest day to observe solstice. Also used shadow. Calendar probably began with winter solstice.
Atsugewi	B	B	Voegelin (1942:143, items 4436-4453); Garth (1953:195). Knew both solstices, and began calendar with winter one. Watched beam of sunlight, and marked it, on wall of lodge. Also noted solstices by sun's relationship to a tree, rock, or hill.
Maidu	W	B	Voegelin (1942:143, items 4436-4453); Kroeber (1922:322). Observed winter solstice by marks in sweathouse, and by sun's relationship to trees or hills, but did not use it to correct lunar calendar.
Konkow	W	B	Voegelin (1942:143, items 4436-4453). Same as Maidu.
Nisenan	W	B	Voegelin (1942:143, items 4436-4453). Winter solstice was observed; it probably did not begin calendar.
Wintu	W	B	Voegelin (1942:143, items 4436-4453); DuBois (1935:68-70). Observed winter solstice by shadows and by sun's position to trees and hills. Some old men observed sun's movement, using two landmarks, to note solstice. One consultant's father was a solstice observer.
Nomlaki	B	?	Goldschmidt (1951:388-389). Solstices not recorded, but had names; equinox was known.
Pomo	B	D	Loeb (1926:266); Gifford and Kroeber (1937:189, item 618). Used solstice in calendar kept by *Yomta* (secret society). Watched solstices by observing over what part of a certain hill the sun would rise.
Coast Miwok	?	?	Kelly (1978:424). Old men paid no attention to the solstices.
Wappo	?	?	Driver (1936:195). Used lunar calendar.
Miwok	W	?	Aginsky (1943:426, item 1271). Winter solstice marked beginning of calendar. Was duty of an old man.
Yokuts	B	?	Driver (1937:86, item 1271); Aginsky (1943:426, items 1270-1271); Gayton (1948:88). Both solstices noted; calendar began with winter one. Was duty of old man.
Monache (Western Mono)	W	?	Driver (1937:86, item 1271); Aginsky (1943:426, item 1271); Gifford (1932:31). Began calendar with winter solstice.
Tubatulabal	?	?	Driver (1937:86, item 1271). No data.
Kawaiisu	W	?	Driver (1937:86, items 1270-1271). Winter solstice observed; time for group drinking of *Datura*.
Koso (Panamint)	B	?	Driver (1937:86, items 1270-1271).
Northern Paiute	W (?)	?	Steward (1941:267-268, 324, item 2721). Calendar began in December.
Nevada Shoshone	W (?)	?	(same as above).
Southern Paiute	W (?)	?	(same as above).
Surprise Valley Paiute	W (?)	?	Kelly (1932:153). Were aware of the solstice, but did not use it in their calendar.
Owen's Valley Paiute	?	?	Driver (1937:86, item 1271). Winter solstice not observed.
Costanoan	W	?	Harrington (1942:29, item 1124); Broadbent (1972:74-75); Geiger and Meighan (1976:92). Sun important deity; offerings made.

Table 1 (cont'd.)

Tribe	Solstices Observed	Observation Method	References and Notes
Salinan	W	?	Harrington (1942:29, item 1124).
Chumash	B	D	Harrington (1942:29, item 1124); Blackburn (1963:141); Hudson and Underhay (1978:51-73); Hudson (1978b:18). Both solstices ritually observed; offerings made. Sun important deity. Knew solstices by watching position of sun rising over horizon.
Gabrielino	B	?	Harrington (1942:29, items 1124-1125); Heizer (1968:38-39, 119); Hudson and Underhay (1978:56-57). Sun important deity; solstice rituals, both solstices marked calendar.
Kitanemuk	B	?	Harrington (1942:29, item 1124); Hudson and Underhay (1978:127-128); Blackburn and Bean (1978:568). Both solstices observed, but winter one began calendar. Sun important deity; rituals and offerings.
Serrano	?	?	Drucker (1937a:25, item 941). No data.
Luiseño	B	?	Boscana (1933:65-66); Drucker (1937a:25, item 941); Tac (1952:94). Both solstices observed in rituals; sun important deity.
Cahuilla	B	B (?)	Hooper (1920:362, note 15); Drucker (1937a:25, item 941); Patencio (1943:113). Cahuilla month names suggest bisolstitial calendar. Knew when certain seasonal changes would occur "when the sun swung to the north." Used sticks to gauge how the sun shone to keep track of time during the year.
Cupeño	B	D	Strong (1929:253); Drucker (1937a:25, item 941). Both solstices determined by two or three old men who watched rising and setting sun; information probably used in calendar.
Chemehuevi	B	?	Laird (1976:94-95). Wise men watched the stars in pre-dawn sky to determine seasons and calendar. Solstices determined by stellar observation.
Yuma	W (?)	D	Drucker (1937a:25, item 941). Solstice recognized by natural landmarks.
Ipai	B (?)	D (?)	Kroeber (1922:323). Presumed both solstices observed.
Tipai (Kuneyaay)	B	D	Spier (1923:358); Drucker (1937a:25, item 941); Lucas (1978). Marked solstices by observation of sunrise to natural landmarks. Yearly ceremony to honor the sun.
Kamia	B (?)	?	Gifford (1931:65-66). Did not observe or mark the solstices as such, but recognized longest and shortest days. Old men kept calendar.
Kiliwa (Baja California)	W (?)	?	Meigs (1939:15). Calendar began in late December.

To determine the extent of solstitial observations among Native Californians, we conducted a literature survey. Table 1 outlines our findings for 49 tribes, with one additional tribe, the Kiliwa, representing Baja California. The column marked "solstices observed" is based upon statements that the solstice(s) was known, observed, or presumed observed by reference to its use in calendrics. Of the 49 California tribes listed, we found evidence that 34 tribes were observing one or both solstices, and six tribes were probably doing so. No data on solstice observation occur for seven tribes, and in the case of two others (Nongatl and Coast Miwok), such behavior is flatly denied.

As shown in Fig. 1, the majority of the state is represented, with a few exceptions: the Yana, the northwestern tribes surrounding the Pomo, the Esselen, the Tataviam and Serrano, the Washo, and the agricultural Mohave; the possibility of a bisolstitial calendar among the Mohave is discussed by Spier (1955:16-23). For most of these tribes, the reason for the hiatus is probably lack of data. Since our survey is not an exhaustive search of the literature, additional pertinent data on the question of solstice observation may surface with further research. For now, it is obvious that most of native California undertook solstitial observations.

Fig. 1. Ethnographic distribution of California tribes reported to have made solstitial observations or were aware of the solstice (source: Table 1).

In southern California, we have noted that these observations had ritual overtones, but in northern California they seem not to have been so highly developed. In both regions, however, the importance of solstitial observations is unquestionably linked to regulating the calendar (either directly as the turning point of the year, or indirectly by beginning the calendar with the lunation in which the solstice occurs), and thus, regulating secular and nonsecular behavior. Our survey indicates that most, but not all, Native Californians used their observational data (direct or indirect) to regulate a calendar. In the northern part of the state, the winter solstice is stressed, while in the southern part it was both. Three tribes (Miwok, Konkow, and Nisenan) were reported to have made solar observations without using them for calendrical purposes.

For the United States and Canada in general, observations of the solstices to regulate a calendar is known for the Eskimo, Pacific Northwest Coast cultures, and Southwestern Pueblos (Cope 1919), and it is quite probable that the southern California bisolstitial pattern was tied into the Southwest, while the northern California pattern was an extension of the Pacific Northwest (Kroeber 1922:323, 1925:874). Certainly there are some rather interesting parallels in sun worshiping, calendrics, and sandpainting between southern California and the Southwest. Central California was influenced by its neighbors, but Loeb (1932:21) also made the interesting suggestion that the western Kuksu cult could very well have had a distant connection with the Pueblo "sun cult." Regardless of emphasis or method of expression, or of independent invention or diffusion, we can be confident that solar observations played an important part in native California calendrics, and that they probably have considerable antiquity.

When solar events are used to regulate a calendar or to time a ritual, some method for observing the sun on a continuous basis is necessary. Obviously, if the solstices are known, they must be watched, and for them to be observed, some method of noting the changing position of the sun is required. We shall describe the methods used below. But what about the equinoxes (March 21-22, September 21-22), when days are equal in length? Cope (1919:121) surveyed this question and noted that nowhere in the United States and Canada was this solar event considered of great importance, although a few tribes appear to have been aware of it (Tewa in the Southwest, and the Nootka of the Pacific Northwest Coast). In native California, the Chumash appear to have been aware of the equinox, and they may well have observed it, although our data are sketchy at best. It seems likely that these people computed the time of the approaching equinox and marked it in the calendar in terms of lunar days (Hudson *et al.*

1977:24, 101, note 26; Hudson and Underhay 1978:126). Goldschmidt (1951:388-389) noted that the Nomlaki did not record the solstices, but that the equinoxes were known. In view of the ease of determining the solstices as opposed to the equinoxes, as well as the overall rarity of documented equinoctial observations for the United States and Canada, it may very well be that Goldschmidt's consultant confused equinox with solstice. Perhaps the only solution to the problem of how prevalent equinoctial observations may have been in remote times is by recourse to archaeoastronomical research.

TECHNIQUES OF SOLSTICE OBSERVATION

Techniques for observing the solstice among Native Americans have been reported in the literature for some time, particularly in the Southwest and on the Northwest Coast. Fewkes (1897:258:259), in his now-classic study of Hopi sun priests, provided an example. He reported that these people watched the rising and setting positions of the sun in relationship to thirteen fixed points on the horizon. The two extreme points were each considered a "house of the sun" and marked the winter and summer solstices. Archaeoastronomical research in the Southwest at Anasazi and Hohokam sites indicates that solstice observations were conducted at least 1000 years ago (Ellis 1975; Williamson *et al.* 1975; Eddy 1977:141-147). On the Pacific Northwest Coast the Kwakiutl technique described is similar to that of the Pueblo one, namely, watching the changing position of the sun against the horizon (Cope 1919:122). By observing such changes daily, the progression of the seasons throughout the year is easily determined—data important not only to Southwest farmers but also to Arctic and Northwest Coast hunter-gatherers.

Fortunately, descriptions on the observational techniques used by Native Californians have appeared in the ethnographic literature; we have noted them in Table 1. We found that while many tribes were known to have made solstitial observations, the methods by which they were made have in many cases gone unrecorded, either because the ethnographer failed to ask or consultants could not recall the technique. The descriptions which were recorded for native California can be easily divided into two basic categories: (1) direct observation of the sun (16 tribes), in which the sun is watched in relationship to the horizon or horizon markers; or (2) indirect observation of the sun (10 tribes) in which a beam of sunlight was observed: a) to strike a mark or series of marks placed on the floor, center post, or wall of a ceremonial structure; b) strike a painting or an object placed in a rockshelter; or c) cast a shadow. In summary, we have found 26 references which apply to 16 tribes, 10 of whom are reported to have used both the direct and indirect methods.

Fig. 2 provides a visual presentation of the distribution. It can be seen that both direct

Fig. 2. Ethnographic distribution of observational methods reported for California tribes (source: Table 1).

and indirect methods can be found in northern as well as southern California. Although data are lacking for central California, it would seem reasonable to infer that their solstice observers probably used both techniques.

The archaeoastronomy data to be discussed in this section represent three years of fieldwork (which, we might add, can be undertaken only at the time of solstices, and only when weather and road conditions permit). Since the presentation of initial findings by Travis Hudson, Ken Hedges, and Robert Schiffman in 1977, other researchers have been alerted to investigate potential sites. There are now some 10 sites known to us which present strong provisional (qualitative) evidence that they were used for solstice observation. Table 2 provides a listing, and Fig. 3 illustrates their distribution. It should be mentioned that the distribution currently reflects only those areas which have been examined by researchers.

Table 2
A SURVEY OF SOLSTITIAL OBSERVATORIES IN NATIVE CALIFORNIA AS KNOWN FROM ARCHAEOASTRONOMICAL RESEARCH
(Abbreviations: W, winter solstice; S, summer solstice; B, both solstices; D, direct observations; I, indirect observations; B, both direct and indirect observations)

Site	Solstices Observed	Observation Method	References and Notes
Painted Rock (Tul-19)	W	I	Underhay (this paper). Indirect sunrise observation of light entering painted cave. Tulare County (Yokuts). Discovered Dec. 21, 1977. Fig. 3, No. 1.
Walker Pass (Ker-317)	B	D	Schiffman (1977a, b). Sunrise observation of a horizon defined in a rock art depiction. Kern County (Tübatulabal). Discovered Dec. 21, 1976. Fig. 3, No. 2.
Condor Cave (SBa-101)	W	I	Hudson and Underhay (1978:53-61). Indirect sunrise observation of light entering painted cave after passing directly over nearby peak. Santa Barbara County (Chumash). Discovered Dec. 21, 1976. Fig. 3, No. 3.
Honda Ridge (SBa-550)	W	D	Spanne (this paper). Sunrise observation of a horizon defined in a rock art depiction. Santa Barbara County (Chumash). Discovered Dec. 21, 1978. Fig. 3, No. 4.
Window Cave (SBa-655)	W	B	Spanne (this paper). Sunset observation of a horizon in which sun sets over prominent peak (shrine?), while sunlight enters cave with petroglyphs. Santa Barbara County (Chumash). Discovered Dec. 22, 1978. Fig. 3, No. 5.
Edward's Cave (SBa-103)	W	I	Junak (this paper). Sunset observation of light striking painted disc on column of rock inside cave. Santa Barbara County (Chumash). Discovered Dec. 21, 1978. Fig. 3, No. 6.
Castle Peak (LAn-511)	S	D	Romani (this paper). Sunrise observation of the horizon from a natural rock window on top of shrine. Los Angeles County (Chumash-Fernandeño). Discovered June 21, 1978. Fig. 3, No. 7.
Viejas Mtn. (SDi-6648)	W	D	Hedges (this paper). Sunrise observation of the horizon from cross-shaped manmade alignment. San Diego County (Tipai-Kumeyaay). Discovered Dec. 21, 1978. Fig. 3, No. 8.
Cowles Mtn. (SDi-5693)	W	D	Hedges (this paper). Sunrise observation of the horizon from bisected circle manmade alignment. San Diego County (Tipai-Kumeyaay). Discovered Dec. 20, 1978. Fig. 3, No. 9.
La Rumorosa (LC-44-18)	W	I	Hedges (1977a, b). Indirect sunrise observation of light entering painted cave and striking painted figure. Baja California (Tipai-Kumeyaay). Discovered Dec. 21, 1975. Fig. 3, No. 10.

Fig. 3. Archaeological distribution of sites from which solstitial observations are believed to have been made (source: Table 2).

Direct Observation

Direct observation involves watching the progression of sunrise or sunset from a fixed point, noting the position of the sun against the horizon. This technique is reported for the Wintu, Atsugewi, Achumawi, Shasta, Klamath, Modoc, Maidu, Konkow, Nisenan, Wiyot, Pomo, Chumash, Cupeño, and Yuma (see Table 1). The method is implied for the Cahuilla by a statement that "when the sun swung to the north . . ." they knew when certain seasonal changes were to be expected (Patencio 1943:113). It is interesting to note that in Ipai sandpaintings, the sun (represented by a disc made from red iron oxide) is believed to actually "make" the horizon and is depicted next to it (Waterman 1910:301).

The Tipai (Kumeyaay) also knew of the technique, but the available data do not connect this behavior specifically with calendrics or solstice rituals. The connection can be inferred, however, by use of the direct historical approach. Johnson (1914:24-25) reported that a yearly ceremony to honor the sun was held by the Tipai on Viejas Mountain in San Diego County. As noted below, archaeoastronomical data for Viejas Mountain indicates that the site was used for winter solstice observations.

Among the few detailed descriptions there is agreement that the observers determined the solstice when the sun appeared to stand still and then reverse direction. For the Wintu this occurred when the sun was seen to oscillate between two points on the horizon for three days, and then reverse direction (Voegelin 1942:234, note 4447). The Pomo proclaimed the solstice when the sun rose over the same spot four times (Loeb 1926:223, 226). One Chumash sunwatcher proclaimed the solstice by reference to three peaks:

> The sun would pass the middle peak on the way south, pass the valley, remain two days, and on the third day would come up again over the middle peak on its way north. He would notify the other Indians of the New Year [Blackburn 1963:141].

Given the ethnographic extent and importance of solstice observations in native California, it seems reasonable to expect that some evidence of this behavior should be found in the archaeological record. In California six known sites appear to be direct solar observatories: Ker-317 in Kern County, SBa-550 and SBa-655 in Santa Barbara County, LAn-511 in Los Angeles County, and two sites, SDi-5693 and SDi-6648, in San Diego County. We will describe each briefly.

Ker-317, located near Walker Pass in Tubatulabal territory, was investigated by Schiffman (1977a, b). He postulated that a rock art motif represented the positions of winter and summer solstice sunrise in relationship to the horizon as seen from the site (Fig. 4a). To test his prediction, sunrise observations were made, and he concluded that both solar events were represented. The winter

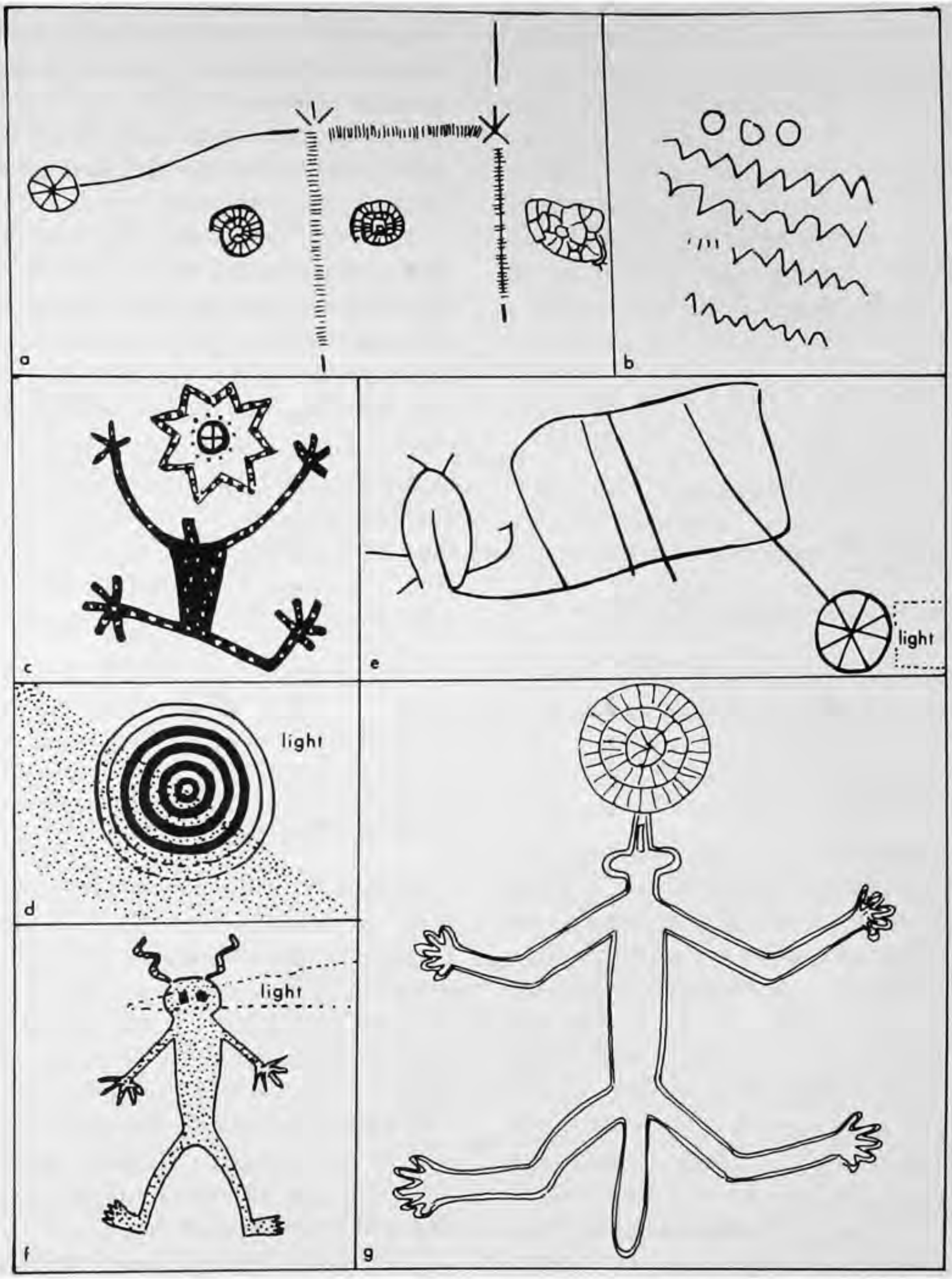

Fig. 4. Rock art motifs associated with direct and indirect solstice observatory sites. Sources: a, Walker Pass, Ker-317 (pictograph, red), from drawing by Robert Schiffman; b, Honda Ridge, SBa-550 (pictograph, red), from photograph by Larry Spanne; c, Condor Cave, SBa-101 (pictograph, black, red, and white), from painting by Campbell Grant; d, Edward's Cave, SBa-103 (pictograph, red concentric circles with white outer circle), from photograph by Steve Junak; e, Window Cave, SBa-655 (petroglyph), from photograph by Georgia Lee; f, La Rumorosa, LC-44-18 (pictograph, red figure with black eyes), from photograph by Ken Hedges.

alignment was with the summit of Owens Peak (Schiffman 1977a, b; 1979, personal communication).

A similar situation exists at Honda Ridge (SBa-550), a rock-painting site in Chumash territory where a possible depiction of solstice sunrise occurs (Fig. 4b). Two locations were inspected by Larry Spanne (1979) as possible observatory points. The first observation was made from a peak located directly above the painting and accessible by a steep, well-defined trail. A notch on the distant horizon defined the point of sunrise. The second observation was made from the rock painting itself, where the sun was seen to rise above a prominent hill some 1600 feet away. This event was accompanied by an additional phenomenon:

> As the sun began to illuminate the higher, unpainted parts of the cliff, glassy surfaces sparkled brilliantly like small crystals framed by the pale morning sky [Spanne 1979:2].

Unfortunately, there is no known Chumash placename which can be identified with Honda Ridge, but in view of the sparkling brilliance of its cliffs brought out by the sun, a placename meaning something like "house of the sun," or "place of the sun," might be expected.

Window Cave (SBa-655), located near Honda Ridge and also investigated by Spanne, consists of a shelter containing petroglyphs including a probable sun symbol (Fig. 4e). A natural window in the shelter wall frames Tranquillon Mountain, the most conspicuous feature on the horizon. One of John P. Harrington's Chumash consultants described Tranquillon Mountain as a "place muy delicado [very sacred] to the Indians" (Harrington n.d.). At winter solstice the sun sets on the summit of the peak and moves down the northern slope, disappearing behind a spur halfway down. Indirect observation phenomena at this site are discussed below (Spanne 1979).

The remaining observatory sites are not associated with rock art. The first of these is Castle Peak (LAn-511), a bead shrine which has been identified with *Tswaya Tsuqele*, an historic shrine located in the western end of the San Fernando Valley. The site, dated between A.D. 1500-1850 on the basis of bead types, may have served both Chumash and Fernandeño. At the top of the outcrop a small pocket in the rocks enables a viewer to stand behind a natural rock window opening to the northeast. John Romani (1978) and Dan Larson (1979) report that summer solstice sunrise, as observed through the window, was seen to occur between two peaks on the distant horizon. They concluded that the solar event seen from the window, at a known sun shrine, suggests that solstice observations may have been made from the site.

Viejas Mountain (SDi-6648) was discussed above as an ethnographically described location for yearly Tipai ceremony to honor the sun (Johnson 1914:24-25). Although a dance circle reported for the mountaintop no longer exists, a high saddle contained a cross-shaped rock alignment (Fig. 5a), the long axis of which was oriented to the southeast. The alignment has since been destroyed by vandals, but observations by Ken Hedges have confirmed that a distant peak on the horizon functions as a marker for the winter solstice sunrise as viewed from the site.

The Cowles Mountain site (SDi-5693), also located in Tipai territory, consists of a rock alignment in the form of a bisected circle, with the bisecting line oriented to the southeast. Observations by Hedges on clear, cloudless mornings at the time of the winter solstice dramatically confirmed the presence of a horizon marker to indicate the point of sunrise (Fig. 5b).

Space does not permit a discussion of archaeological sites which are unconfirmed but nonetheless potential candidates for direct solar observatories. Some have rock art motifs which parallel those reported by Schiffman and Spanne. Examples of such motifs which

Fig. 5. Winter solstice phenomena in San Diego County (photographs by Ken Hedges). Upper: Cross-shaped alignment at Viegas Mountain, oriented (upper left) with winter solstice sunrise. Lower: First gleam of winter solstice sunrise as seen from the bisected circular alignment at Cowles Mountain. Note sun's position to prominent horizontal feature.

can aid in locating observatory sites are presented in our summary.

Indirect Observation

Indirect solar observation involves the use of a beam of light to strike something or to cast a shadow. In the ethnographic literature, this practice is noted particularly for several northern California tribes. Commonly, a beam of light is described as striking a series of marks cut into a tree near the village, or made on the walls of a house or cut into the centerpost of a large ceremonial house. The marks represent the "shortest" and "longest" days of the year (see Table 1).

For southern California, the data are limited to the Cahuilla. A sketchy account states that they: ". . . put up signs to gauge how the sun shone," moving sticks to the right or left to keep track of time during the year (Patencio 1943:113). We will return to the use of sticks in keeping calendrical records.

By far, the most difficult archaeoastronomical site to locate is one associated with indirect solar observations. The archaeological examples involve the emphasis of rock art by sunlight, or the identification of plausible locations for sunsticks, gnomons, or other objects—variations which are not expressed in the ethnographic literature. To date, five sites are known which suggest the use of this technique.

The first of these is Condor Cave (SBa-101), a richly painted Chumash rock art site. Here, a beam of sunlight was observed to enter the otherwise darkened cave at the time of winter solstice sunrise through a tiny, man-made "window" bored into the southeast wall. The sunlight enters the cave after having cleared the summit of an outcropping in front of the window. Daily variation in the position of sunrise relative to outcropping and window has not been measured due to inclement weather and the remoteness of the site. However, it was found that the relationship no longer existed by late January. On the basis of these observations, Hudson and Underhay (1978:51-73) concluded that the site was probably not used to predict the solstice, but rather to honor it in ritual activity. Sticks or some other movable objects may have been placed in line with the beam of sunlight to increase accuracy. This is ethnographically known for the Chumash, as in the case of erecting a sunstick at the time of the winter solstice. An association of the art with the winter solstice does seem supportable: one motif, for example, coincides with ethnographic descriptions of the bodypainting and hand gestures associated with the winter solstice, in particular the prayer given by the sun priest to entice Sun to return (Fig. 4c).

Near Condor Cave a south-facing rockshelter contains a natural stone column upon which is painted a set of concentric circles (Fig. 4d). When first observed at sunset on the winter solstice, light entering the cave bisected the motif diagonally. The possibility exists that full illumination of the motif occurred earlier, although Steve Junak, who visited the site, could not confirm it. Because the sun must be far to the south to even enter the cave, the phenomenon must occur, with some unknown variability, near winter solstice (Junak 1979).

At Window Cave (SBa-655), the winter solstice sunlight was observed to enter through the window which also frames the view of sunset on Tranquillon Mountain (discussed above as direct observatory). The sunlight strikes one wall of the shelter as a long, narrow band, directing the viewer's gaze toward a probable sun motif (Fig. 4e). Beyond the petroglyph the sunbeam strikes the floor of the shelter to form a pool of light (Spanne 1979:4). This conceivably could mark the placement of a gnomon or sunstick in a situation analogous to that postulated for Condor Cave.

At La Rumorosa (LC-44-18), in northern Baja California Tipai territory, Hedges observed the patterns of sunlight on the wall of a painted rockshelter at winter solstice sunrise. First light falls on a white circular design and extends in a long, pointed streak toward a red-horned anthropomorphic figure (Fig. 4f and frontispiece). The sunlight skips over the figure, which is located in a slight recess, and shines on the wall beyond, forming a sharp point of light which gradually extends back toward the sun, falling across the eyes of the figure (frontispiece to this article). As more light enters the rockshelter, the rest of the figure's body is illuminated (Hedges 1977:2).

Significant points in this sequence appear to be the position of first light and the path of light across the eyes of the red figure. At periods of time greater than 10 days away from solstice this unique sequence of events does not occur. It is apparent that the figure has been placed on the wall to take advantage of a unique play of sunlight at this particular time of the year.

Painted Rock (Tul-19), in Yokuts territory, is a rockshelter with a large southeast entrance. One of the more conspicuous polychrome paintings is a large figure on the ceiling (Fig. 4g). Oriented to the southeast, it depicts a large animal, perhaps a coyote, with what appears to be a solar symbol in its mouth. One of Latta's (1949:24) consultants stated that the animal was *Sok-so-uh*, a supernatural being holding the sun in its mouth. Hudson theorized that the figure could represent players in the celestial peón game decided at winter solstice between Sun and Sky Coyote (Chumash); Sun and Sky Deer or Earth (Kitanemuk); Sun and *Tihpiknits*, a feathered supernatural (Yokuts) (Hudson and Underhay 1978:32-33; Hudson and Blackburn 1978); or in the case of Painted Rock, Sun and *Sok-so-uh*. The depiction therefore suggested that Painted Rock was used for winter solstice rituals, and thus possibly for solstice observations.

To test the theory, Ernest Underhay visited the site. Despite a cloud cover, the sun was observed by Underhay to rise in a gap on the horizon and eventually to illuminate a small recess in the northwest corner of the shelter. He concluded that the phenomenon observed would be limited to the period around the winter solstice, and that Painted Rock could have served astronomical functions (Underhay 1977).

Space does not permit a discussion on potential indirect observation sites which remain unconfirmed.

SHAMAN-PRIESTS AS SOLAR OBSERVERS

The evidence presented thus far leads to the conclusion that artist, shaman, and solar observer were one and the same, either as an individual or collectively as members of a cult. Other data support the association, such as rock art, groundpainting, and shamanism (DuBois 1908:87; Hedges 1976; Blackburn 1977), or rock art, shamanism, and astronomy (Hudson and Underhay 1978:56-61, 147; Hudson 1978a).

For the Chumash, the connection of artist, shaman, and astronomer is supportable from the interrelationships of astronomical subjects, rock art, winter solstice rituals, shamanism, *Datura*, mythology, and supernatural power. It would appear, at least for these people and perhaps for the Gabrielino, that the individual responsible for the winter solstice ceremony was also responsible for whatever acts of supernatural power were necessary on the part of man to placate Sun, either in ritual or in rock art, and that the same individual also regulated economic, social, and ritual life by use of a solar calendar. These responsibilities belonged to the elite—the *paha* in Chumash society served as sun priest during solstitial ceremonies, while his twelve helpers, *'antap*, were the rays of the sun (Hudson *et al.* 1977; Hudson and Underhay 1978). A connection between shamanism, rock art, and prayers to the sun for the Gabrielino is given in a narrative published by Blackburn (1975: narr. 79); we have already noted the interesting title of "sun" given to ritual officers. A similar association between shamanism, rock art, and prayers to the sun can be made also for the Yuki. Kroeber (1925:198) described the techniques of a Yuki shaman who said: ". . . the sun spoke and ordered me to cure him." During the cure the shaman painted a flat rock red and white and addressed the sun.

A survey of the ethnographic literature reveals a rather diverse and fragmented picture for the state, but nonetheless a general thesis can be formed that observations of the solstices were performed by the elite—a chief, headman, leader of a secret cult, "old man," or elder. Among the Pomo, it was the leader of the secret society who conducted solstitial observations and kept track of time, using bundles of sticks (Loeb 1926:226). For the Wappo, the chief is mentioned as time-keeper, also using sticks (Driver 1936:195-196), while among the non-solstice Coast Miwok time-keeping was the duty of an "old headman" (Kelly 1978:424). Driver (1939:400) recorded that calendrics among the Wiyot were conducted by the head doctor or chief, and that this same individual conducted observations of the rising and setting position of the sun on the horizon.

In southern California, it would appear that the men who kept track of time were the elite, who used this knowledge to regulate ritual and economic behavior. Among the Tipai, elderly men discussed the months (Gifford 1931:65-66); it has been noted that there was a position of sunwatcher chosen by his fellow shamans, undergoing ritual purification for the task. He knew the time to go watch the sun, and used certain trees or stone alignments as reference points (Florence Shipek, 1977, personal communication). Councils of elders to discuss the calendar and determine which star's appearance marked a given month, signalling the time to exploit various natural resources, have been noted for the Luiseño (DuBois 1908:165) and for the Chemehuevi (Laird 1976:94-95). Hooper (1920:362) notes this practice also among the Cahuilla:

> Old men studied the stars very carefully and in this way could tell when each season began. They would meet in a ceremonial house and argue about the time certain stars would appear—this was very important because upon the appearance of stars depended the season for certain crops. They never went into the mountains to gather until a certain star appeared.

The use of stars as time-markers is also reported for the Gabrielino, Salinan, Kitanemuk, Costanoan, Chumash, Ipai, and Tipai (Harrington 1933:186, 246, 1942:29, items

1123-1126; Hudson and Underhay 1978:126-139). How important this may have been elsewhere in the state is unknown, but there is evidence that the Yokuts watched the appearance of certain stars to mark the time when the first salmon would appear (Gayton 1948:162, 165).

Solstice observers among the Cupeño were described simply as "three old men" whose observations were considered necessary for the calendar and the economic and ritual activities it regulated, but their position seems not to have been official (Strong 1929:253).

In northern California, the Wintu are described as having "some old men" as solstice observers who are also responsible for time-keeping, using sticks (DuBois 1935:68). Similar customs are described for the Central California Miwok, Monache, and Yokuts (Aginsky 1943:426). A calendric mnemonic device used by the Yokuts, consisting of beads placed over a bone, stick, or the primary feather of a pelican, served to keep track of lunations (Driver 1937:86, 127, item 1286a).

While the data thus far indicate a connection between solstice observer and time-keeper, there are also abundant references concerning time-keeping alone. We do not know if these time-keepers were also solar observers, but many of the tribes concerned are known to have had both positions: Tolowa (Drucker 1937b:240), Wappo (Driver 1936: 195-196), Atsugewi (Garth 1953:196), Surprise Valley Paiute (Kelly 1932:154), and Nomlaki (Goldschmidt 1951:389). A Klamath myth suggests the use of sticks to maintain calendrical records (Spier 1930:220). An "old man" is reported as time-keeper for the Nisenan; his sticks represented a count of lunations (Beals 1933:357). The Cahuilla account describing their use of sticks to keep track of solar events has been mentioned above (Patencio 1943: 113). It is reasonable to infer that in many of these cultures the time-keeper was also an astronomer-shaman, and that the role was also an elite one.

The function of time-keeping was to regulate not only ritual activity, but also economic, legal, social, and community affairs. The calendar, based upon interaction with and interpretation of powerful celestial supernaturals and understood only by the elite, provided divine sanction for many aspects of communal behavior. Given the importance of making solar observations, keeping track of lunations, and watching stellar changes, it appears reasonable to assume a strong connection between shaman and astronomer. As an astronomer and solar observer, this individual predicts when important cosmic events take place, but as a shaman he interprets or manipulates the meanings of those events.

To judge from the archaeoastronomical evidence from ten sites, it is possible to identify to some degree expressions of this behavior in the archaeological record. We can say with reasonable confidence that these sites were accorded a high degree of religious importance, as mirrored by their rock art or shrine settings, and that in the majority of cases the emphasis—as suggested by the ethnographic record—was upon the winter solstice. These observatory sites were visited by astronomer-shamans, who communicated their knowledge with others from generation to generation. For most of the viewing period the elite probably undertook these activities in private, but we can imagine that some were large, community-oriented affairs, especially at solstice time. Viejas Mountain, with its winter solstice alignment and probable dance circle, is an example.

Obviously, there is a great potential for discovering many more solar observatory sites in the state. Our findings can be summarized in a way to aid in these discoveries.

SUMMARY

Archaeologists can expect to find solar observatories over much of the state. The ethnographic data indicate that these will align with the winter solstice in northern California, and with both solstices in southern California. Direct and indirect observational methods can be expected everywhere.

Factors which affect solar observatories in any given area would include topography, weather conditions affecting visibility, demography, socio-political interaction, and intensity of sun worship. Since these factors vary from region to region, we expect that the number and location of observatories will also vary.

Because our data on locational parameters are limited to ten sites, we can say little in terms of regional or cultural variability, but we can make generalizations for southern California which may be applicable to the state as a whole.

First, most observatory sites are associated in some way with high elevations. They are either directly situated on them or located in such a way that they form solar alignments with conspicuous horizon features. Doubtless in southern California many of these peaks were considered sacred, and some, such as Castle Peak, served as shrines. The ceremonial setting at Viejas Mountain is another illustration of sun watching associated with ritual behavior.

Second, because solar alignments between sites and landforms are involved, archaeologists should make good use of this relationship to locate observatories. Conspicuous features on the horizon can be used as focal points to plot sets of solstitial azimuths. Lines drawn from such points in the directions of winter and summer solstice sunrise and sunset provide rough estimates of where to look for potential solstice sites. Solar azimuths vary according to latitudes and elevations of both observatory and horizon feature; thus, the method can only approximate areas where observatories are likely to be. Special attention should be given to where these solar azimuths pass into regions known for rockshelters. An example is Window Cave (SBa-655) where a solstice azimuth from Tranquillon Mountain passes through the site area. Researchers will have to take great care to ensure that such alignments were culturally recognized, and not just the product of "chance."

Third, while indirect observatory sites must have solar alignments, direct observatory sites indicated by rock art need not always be precisely aligned. Astronomer-shamans may well have selected a location from which to make solar observations, while a nearby shelter with rock art could have served as ritual retreat. Honda Ridge (SBa-550) is an example with a probable observatory point connected by trail to the rock art site.

Fourth, because the sun's position in relationship to the horizon may be symbolically depicted near Walker Pass (Ker-317) and at Honda Ridge (SBa-550), archaeologists can make use of rock art motifs to locate potential direct observatory sites. To illustrate this concept, a general survey of the rock art literature was made to locate motifs which suggest depictions of the sun in relationship to the horizon. The results are provided in Figs. 6-9 and Fig. 10. Since these drawings are in some cases derived from crude sketches or incomplete renderings, we offer them merely for the sake of illustration. It can be seen that all of these motifs share two things in common: a wavy-line, zigzag, or simple curve which is horizontally-oriented, and one or more circular figures. A single disc (Figs. 6-8) may represent either solstice; while two discs (Fig. 9) may depict both. Three circular motifs (Fig. 9f, h), a rare occurrence, may symbolize the equinox in addition to the solstices, but it is equally possible that this motif represents the sun's positional change close to solstice.

Fifth, there is the possibility that more than one observatory site was used by the astronomer-shamans on the same day. One example concerns Honda Ridge (SBa-550) and Window Cave (SBa-655), sites situated so near one another that a shaman could easily have made a sunrise observation at one

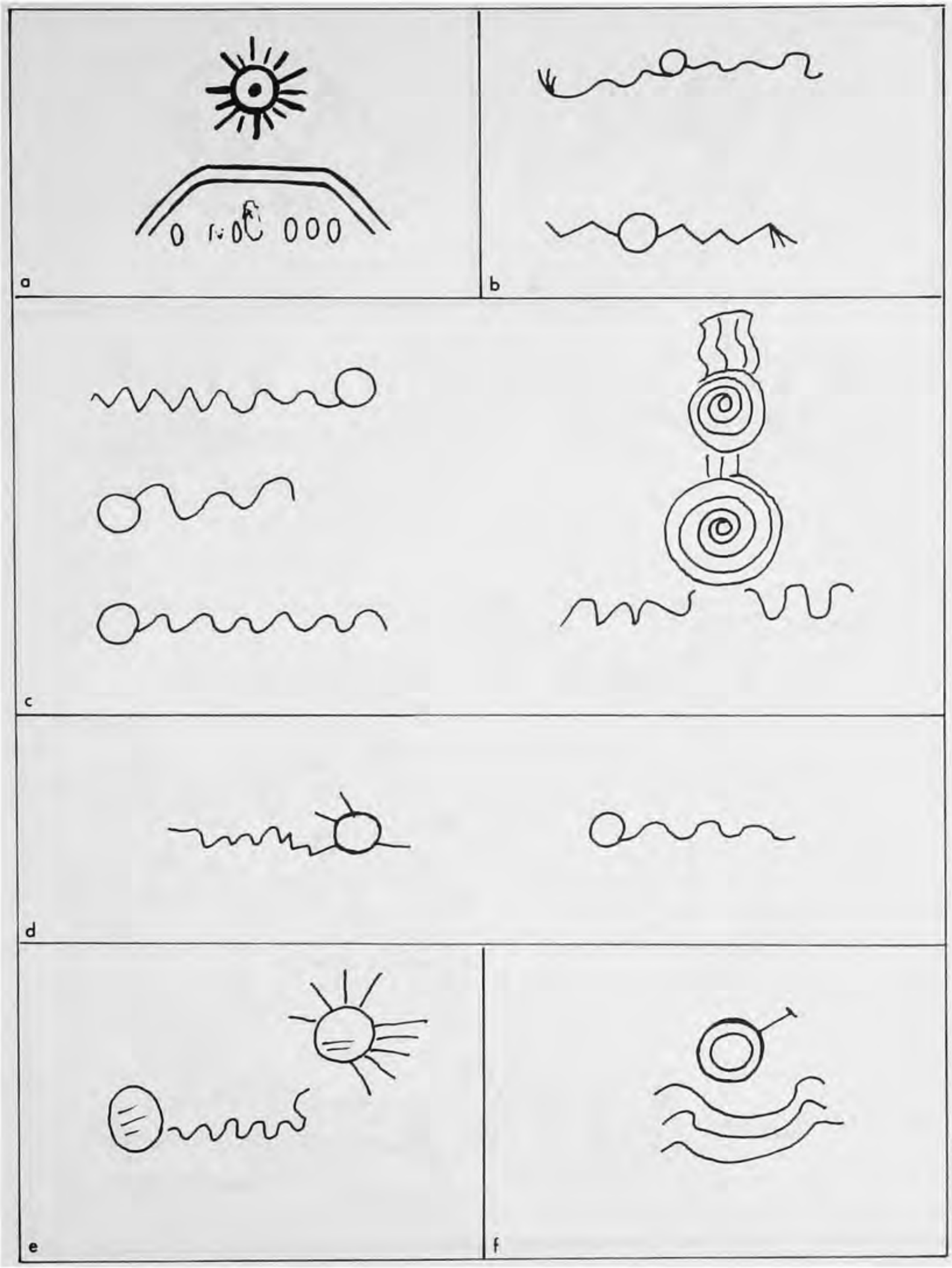

Fig. 6. Possible depictions of direct solstitial events in California rock art. Sources: a, Juniper Cave, Siskiyou Co. (petroglyph), from photograph by Helen Crotty; b, Las-129 (petroglyph), Heizer and Clewlow 1973: Figs. 105c-e; c, Nev-6 (petroglyph), Heizer and Clewlow 1973: Figs. 179 l, o, Pl. 8b; d, Iny-396 (petroglyph), Heizer and Clewlow 1973: Figs. 68e, 69a; e, Site 38, Owens Valley (petroglyph), Steward 1929: Pl. 26g; f, Mno-8 (petroglyph), Heizer and Clewlow 1973:Fig. 130j.

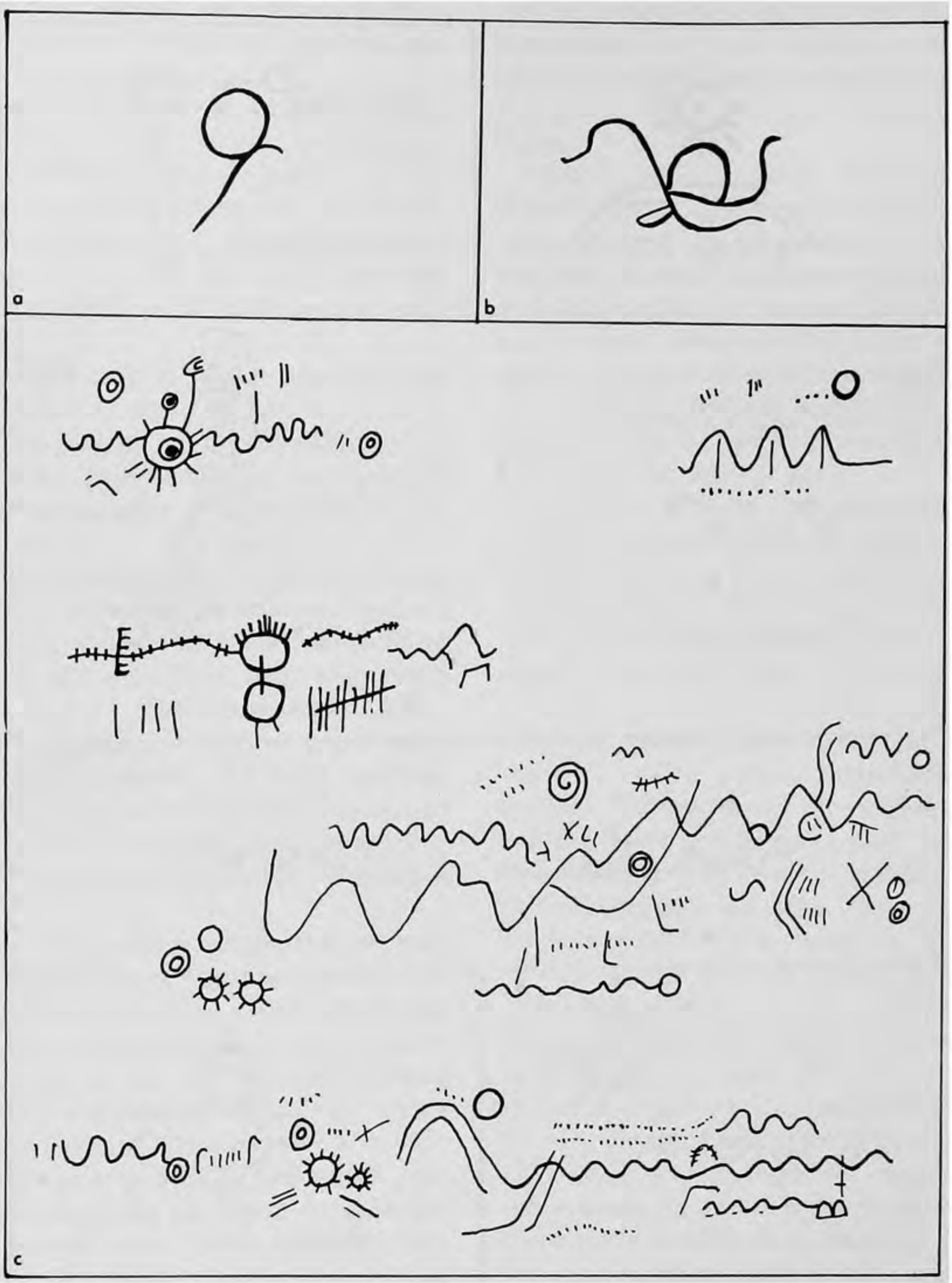

Fig. 7. Possible depictions of direct solstitial events in California rock art. Sources: a, Hole-in-the-Wall, Essex (petroglyph), Smith and Turner 1975:78, Fig. H60; b, Painted Rock, Essex (petroglyph), Smith and Turner 1975: 50, Fig. H23; c, Mod-1 (petroglyph, some with paint), Heizer and Clewlow 1973: Figs. 151b, 152b, 153b, 154b, 155b.

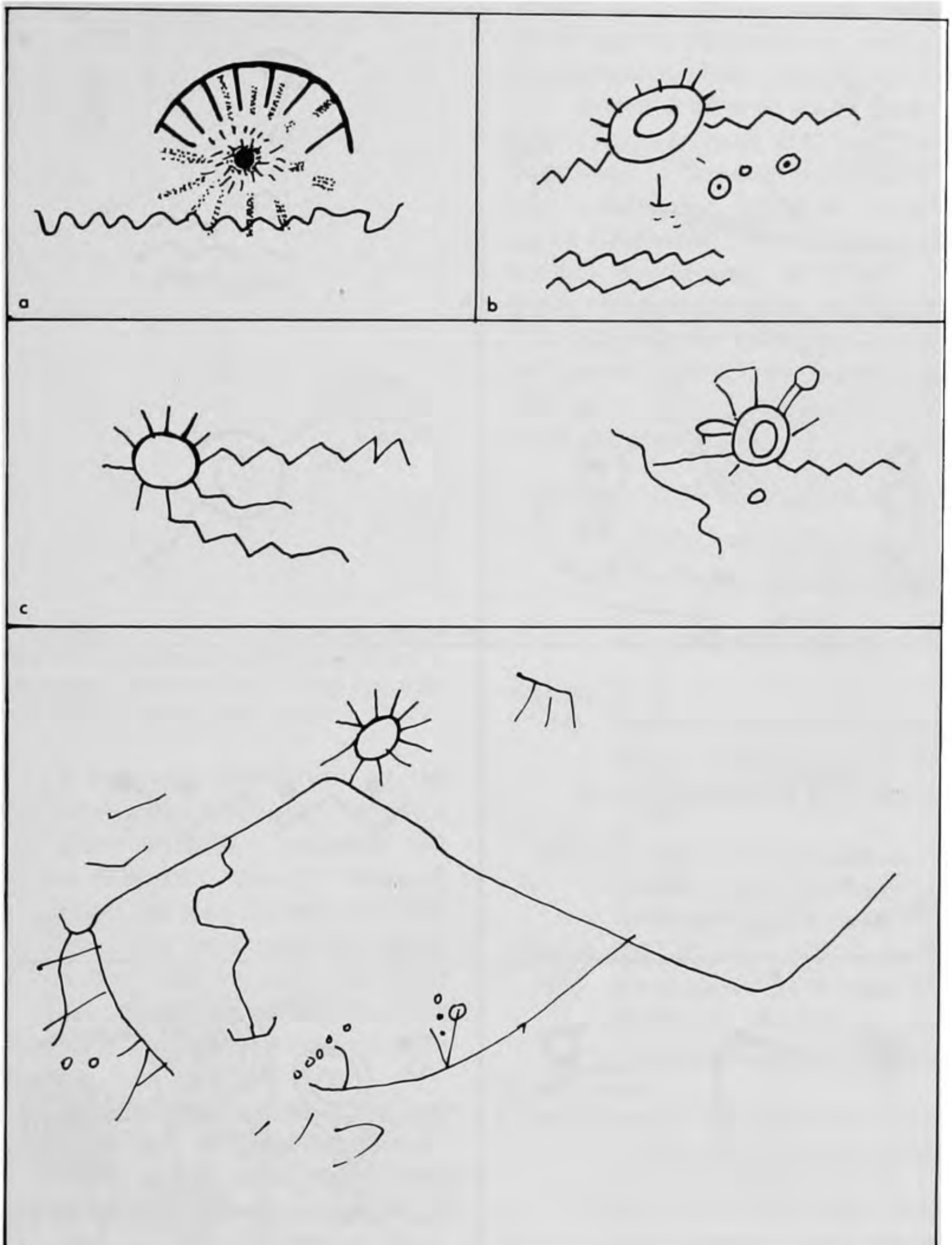

Fig. 8. Possible depictions of direct solstitial events in California rock art. Sources: Ker-17 (pictograph, red and white), Heizer and Clewlow 1973:Fig. 84a; b, Site 11, Tule Lake (petroglyph), Steward 1929:61, Fig. 3; c, Nev-5 (petroglyph), Heizer and Clewlow 1973:Figs. 176e, g; d, Sha-39 (petroglyph), Heizer and Clewlow 1973:Fig. 247.

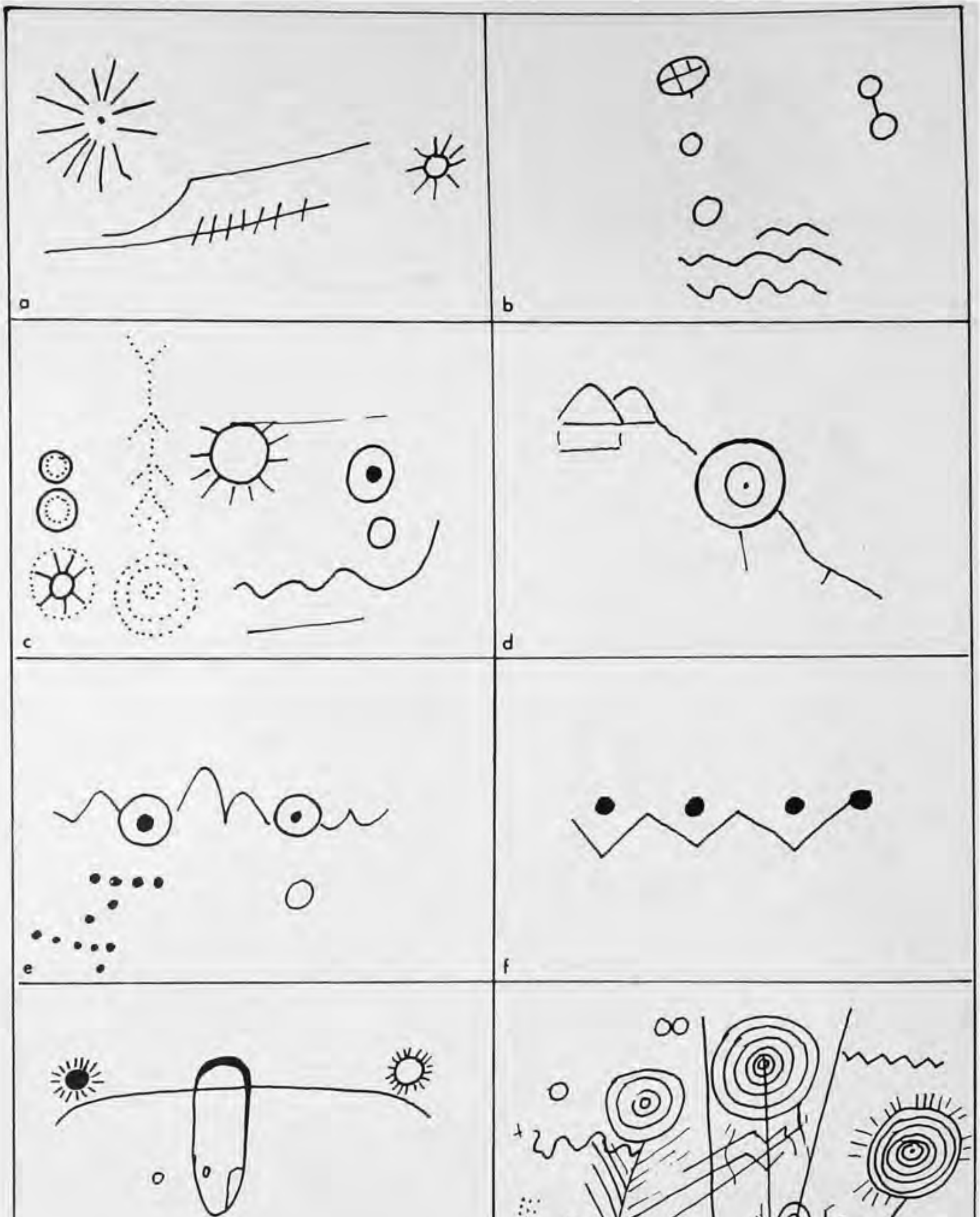

Fig. 9. Possible depictions of direct solstitial events in California rock art. Sources: Tul-272 (pictograph, red), Heizer and Clewlow 1973:Fig. 376b; b, Site 32, Stanislaus River (petroglyph), Steward 1929:69, Fig. 13; c, Mod-23 (pictograph, polychrome), Heizer and Clewlow 1973:Fig. 166d; d, Site 15, Northeast California (petroglyph), Steward 1929:Fig. 5; e, Site 17, Northeast California (petroglyph), Steward 1929:Pl. 23h; f, Riv-16 (petroglyph), Heizer and Clewlow 1973:Fig. 384e; g, Ker-21 (pictograph, red), Heizer and Clewlow 1973:Fig. 83b; h, Sac-228 (petroglyph), from drawing by Louis Payen.

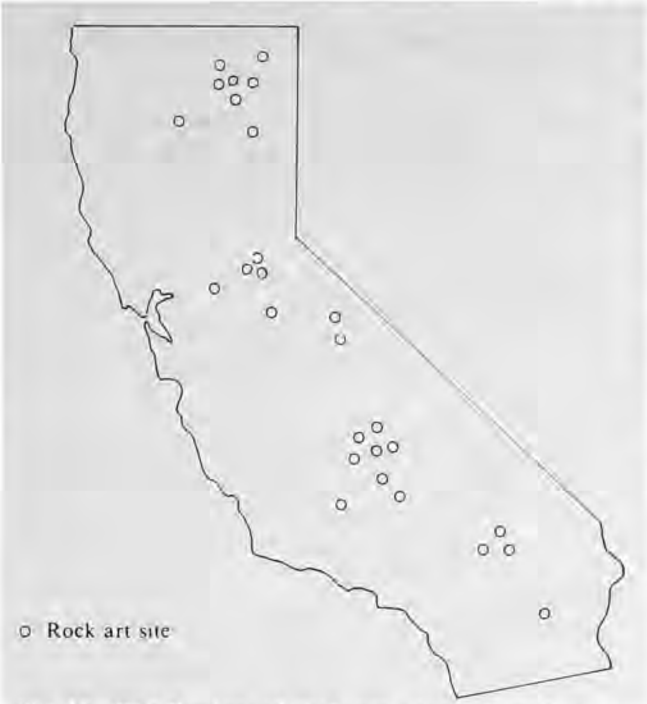

Fig. 10. Distribution of rock art sites having designs which *may represent* direct solstice observation or behavior connected with it. See Fig. 3 for distribution of known solstice sites.

(SBa-550) and a sunset observation at the other (SBa-655). A similar case could be made for Condor Cave (SBa-101, sunrise) and Edward's Cave (SBa-103, sunset). Although we do not know if the sites in each pair are contemporaneous, this does open the possibility that solstitial observations, and their associated ritual, may have taken place on the same day at a number of locations near a major village.

Last, while on-site observations of sunrises and sunsets at suspected archaeoastronomical sites does provide useful data, researchers must be aware that such data should be collected in addition to the recording of quantitative observations. If we are to learn anything concrete about such sites, suspected alignments must be measured carefully and accurately, with the resultant data mathematically tested against computations of refractions and declinations for the era in which the site in question was in use. A quantitative analysis of the errors in measurement should also be made so that they too can be tested against the accuracy and precision of the alignments themselves. Ethnographic data have helped, but until such studies are more fully complete (and this includes the sites mentioned in this paper), the state of knowledge concerning solstitial observations in native California in the archaeological record remains provisional. Hopefully, as quantitative analyses are made, the future will hold for us not only the ability to accurately identify and assess solstitial sites, but also the exciting task of reconstructing the cultural behavior which produced them.

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