I. AN HYPOTHESIS ON OLMEC ASTRONOMY, WITH SPECIAL REFERENCE TO THE LA VENTA SITE[1]

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This paper is the outgrowth of an inquiry to discover, if possible, the reason for the orientation of the main axis of the Olmec site of La Venta along a line 8° west of true north. The site (Fig. 1) consists of a group of mounds arranged on, or on either side of, a central axis leading north from the conical La Venta "pyramid." This architectural complex represents a tremendous expenditure of effort not only to build the huge pyramid construction itself (with a mass of about 3.5 million cubic feet), but also the mound and court complex to the north whose base was in part artificially built up to maintain its direction rather than being allowed to simply follow the natural contour of the land (Heizer 1968:17; 1961:44). It therefore seemed probable that the carefully planned orientation to 8° west of north was not simply a random placement, but a deliberate alignment established for some specific reason or purpose (Heizer 1961:51). It has been earlier suggested, though admittedly without supporting evidence, that the La Venta pyramid may have performed some astronomical horizon-sighting function, i.e., serving as an "observatory" (Heizer, Graham, and Napton 1968:137).[2] The results of the present investigation seem to support this idea.

Before continuing, it must be stressed that the writer is not an astronomer and cannot profess to have more than the most rudimentary knowledge of astronomical principles. However, having become interested I began to make investigations[3] which have resulted in an hypothesis which is presented here and which seems to explain the orientation of La Venta site; at the same time it provides the lead for suggesting an interpretation of

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[1] Superior numbers refer to Endnotes which will be found following the text. The reader's attention is called to Endnote 1 for meanings of certain abbreviations used in this paper.

certain elements of Olmec symbolism. While the analysis offered here is only a theory based on relationships which seem due to more than mere coincidence, I am well aware that there are areas of the topic yet to be explored and also that some details remain subjective opinions which may require modification as more information comes to light. However, as an entirely new explanation of the nature and purpose of the La Venta site complex, I hope it will elicit interest and invite suggestions, with the ultimate objective of gaining further insight and a better understanding of Olmec culture.

The Olmec "heartland" is situated on the lowland Gulf coast of southern Veracruz and northern Tabasco and the small volcanic area of the Tuxtla Mountains. Three major Olmec sites in the area are La Venta, Tres Zapotes, and San Lorenzo Tenochtitlan. All three may have been political-religious capitals or ceremonial centers of the Olmec group during the first millennium B.C., but of the three sites, La Venta seems to have been the preeminent if we judge from the dimensions of the site, the number and size of stone sculptures, the unique fluted-cone "pyramid," the wealth of jade objects in offering caches, and other features. However, it is not the purpose of this paper to discuss the La Venta site in comparison or contrast to other major lowland Olmec sites, something which has been recently done by Bernal (1969), but merely to examine the possible reasons why the builders of the La Venta site chose to align the constructions along a precise line of orientation.

The La Venta site lies on a small "island" with a surface area of about two square miles, formed by the Tonala River and its backwater sloughs in the alluvial coastal plain of northern Tabasco, about ten miles inland from the shore of the Gulf of Campeche. There is no evidence that there has been any change in the island's dimensions, elevation, or situation with reference to the river and surrounding swamps in the last few thousand years. Except where there are swamps, the whole region is covered with dense tropical forest (West, Psuty and Thom 1969). The island of La Venta will not support more than 150 persons by slash-and-burn farming (Drucker and Heizer 1960:36-45). Since this number of persons would have been quite insufficient to have provided the labor force to build and maintain such a large site, one may surmise that the site was a detached ceremonial precinct which was built by a population living elsewhere. The varied constructions at the site are all of a religious nature, and no occupation debris or trash deposits occur anywhere within the area of the central site itself (Heizer 1961:45). Trash deposits occur outside the site area (Drucker 1952) but they do not indicate that a numerous population lived on the island, and this refuse can be attributed to a resident corps of priests and their attendants who maintained the site and served the religious needs of the people. Thus the known facts strongly imply that La Venta was an isolated ceremonial center which existed at some distance from the population which built and supported it (Drucker and Heizer 1960:44; Drucker, 1961; Heizer 1961).

The site consists of a linear complex of constructions made of heaped-up clay, the centerline of the alignment bearing 8° west of true north. These mounds extend for a distance of over a mile along the low central ridge of the island. Main mounds are bisected by the north-south centerline, and secondary mounds are paired, lying equidistant on either side of the main axis (Fig. 1). The general bearing of the island's central ridge, though roughly that of the site's centerline, diverges some degrees to the east at the northern end of the site so that the builders were required to deposit at those points some very extensive earth fills in order to permit the site to maintain its precise line of orientation (Drucker, Heizer, and Squier 1959:63, 121, 124). It was for this reason that it was suspected that the site's alignment may have been astronomically determined. Furthermore, the location of the site is such that the apex of the pyramid provides a spectacular view of the whole sky overhead, appearing as a vast inverted bowl resting on the wide perimeter of the horizon-line; the central axis leading from the pyramid carries one's gaze northward out across the flat swampy lowlands to the smooth horizon-line of the sea where it meets the sky. The pyramid has every qualification to make it an ideal astronomical observation platform in a locality where the tall forest trees may reach higher than 30 meters.

La Venta is situated at 18° north latitude; therefore the North celestial pole would lie 18° above the horizon, and stars within 18° of the

South celestial pole would not be seen. As the earth rotates on its axis, the stars would seem to rise in the east after sunset and move westward across the sky (i.e., clockwise for an observer looking southward). The stars within 18° of the North celestial pole would never set, but would be continuously visible above the northern horizon after sunset as they rotated counter-clockwise, as seen by an observer facing northward. Since a complete rotation takes approximately 24 hours, each circumpolar star will describe a half circle, more or less, in one night for an observer at latitude 18° North. In the journey from east to west, the half-way point lies on an imaginary line bisecting the sky running north and south. This line is the meridian, and when a star is on it directly overhead from the observer's position, it is at zenith. When a star is on the meridian at midnight, it means that after sunset that star is in the east, and by sunrise it has moved across the sky to the west. When a star has traveled an equal distance from one side of the meridian to the other on one night (thereby crossing the meridian or "culminating" at midnight), its progression is easy to measure, and such an event is a logical way to begin the observation of that star's motion through the year.[4]

The sun, the moon, and the stars can all be used to measure the passing of time, for each follows a certain and predictable path through the sky, varying slightly from day to day. By using devices such as solstice markers or shadow sticks, the length of a year can be measured by noting the exact day when the sun arrives at its most northern or southern point (summer and winter solstices) on two successive years. This time interval is termed the solar or tropical year. The year can also be measured by observing the precise day and hour when the sun, the earth, and a star are exactly in line (i.e., the midnight meridian transit of that star). The time interval between two successive midnight meridian transits of a star is a sidereal year. A sidereal day is four minutes shorter than a solar day, so the two measurements do not exactly coincide. Stars will appear to shift west about 30° (two hours) each month, until they reach the same position at the same hour again after the lapse of a year.

During a human lifetime, stars (without the aid of precise sighting instruments) will appear to remain fixed in relation to the celestial pole.

However, the effect of precession causes a small drift westward of the vernal equinox in the amount of $1^{\circ}.396$ per century. The diagram in Fig. 7 illustrates the slow precessional path followed by the celestial pole around the pole of the ecliptic. Polaris conveniently marks the North celestial pole for us today, although it will not be at its closest until the year 2100 when it will still be 28 minutes of arc from the pole of the equator. Nevertheless, it has been sufficiently close for the past 2000 years to serve as a reference point of observable phenomena in the northern sky, as it appears stationary in position relative to the motion of the stars. The last star that was close enough to serve as a Polestar was Alpha Draconis in 2600 B.C. However, it must be borne in mind that in the millennia between that era and the present one, the North celestial pole was not marked by any star but was instead a point in space.[4]

According to modern evidence, the epoch between 3000 and 1500 B.C. witnessed the full development of agriculture from the earlier gathering economy of Mesoamerican peoples (MacNeish 1964). With the preoccupation of planting and harvesting times, anticipation of rainy and dry seasons, some knowledge of where the farmers were in the year would have been essential. There must have been a period of intense interest in forecasting the seasons and weather pattern. Days and months can be counted by moons, but this tells nothing of seasons; furthermore, twelve lunar months add up to only 354 days which is 11 days short of the solar year. The movements of the sun are a good indication of seasonal change. Correlating the solar year with the nightly celestial motions at the same time would provide a fairly accurate measure of time, and thus allow a determination of the date of the beginning of the rains, the times for clearing, burning, planting, harvesting, etc., etc.[5] It seems implicit that there must have been a vital need for some sort of calendar in order to correlate the various natural measures of time, the solar day, the lunar month, and the year of the seasons. Such a feat is not a simple one for, as we have seen, the measures do not fit evenly into one another. I think that the Olmecs were preoccupied with this matter, and that the pyramid and mound complex were built for the purpose of making astronomical observations and calendrical computations.

One of the most useful methods for calculating the passage of time, and one which has been in widespread use throughout the northern hemisphere, is the employment of the constellation Ursa Major as a time clock. The usual method has been to line up the "pointer" stars, Alpha and Beta, with some other point of reference. Fig. 8 shows how such a device is used today, based on the rotation of Ursa Major about Polaris. The configuration of the four stars (Alpha, Beta, Gamma, and Delta), comprising the "bowl" of the Big Dipper, makes an excellent star clock (termed "Nocturnal") in the northern hemisphere, because it is so easy to recognize, because it is circumpolar, and because it is visible (cloud cover permitting) throughout every night of the year.

It seems very possible that early peoples in Mesoamerica may have used Ursa Major as a time-keeping device, and the way this may have come about is proposed below. The theory accounts for the alignment of La Venta, as well as explaining certain aspects of Olmec art which will be demonstrated further on in the discussion. At first it was only a guess that the La Venta people may have been concentrating on the nocturnal course of Ursa Major. In order to check this an investigation was made of the right ascensions and declinations of Alpha, Beta, Gamma, and Delta Ursae Majoris in the second and first millennia B.C. It will be recalled that construction of Phase I at La Venta is radiocarbon dated at about 1000 B.C. (Berger, Graham and Heizer 1967). Also, it must be assumed that the planned lay-out of the site was based on knowledge gained by a long period of celestial observations made before that date. In other words, in view of the elaborate plan of the site and the effort spent in constructing the pyramid that we believe was to be employed as an observation platform, it appears that the La Venta site planners already had in mind their intended object of focus in the sky.

I believe that, for the Olmecs, the critical time for observing Ursa Major was the night of June 21 of the Gregorian calendar, due to a learned tradition originating at a much earlier date. It would have been a convenient day to begin the year count and correlate nocturnal stellar motions with the daily path of the sun. Fig. 9 shows that at 2000 B.C. the center of the bowl of the Big Dipper lay almost exactly on the meridian at midnight on June 21. At 18° north latitude, Beta Ursae Majoris (δ = +68°.32) and Gamma Ursae Majoris (δ = +70°.55) were both below the horizon by about 3° and 1° respectively (allowing for atmospheric refraction) as they crossed the meridian, and therefore would not have been visible to the observer at the time of their transit. The center of the trapezium of the Big Dipper, as determined by the intersection of the Alpha-Delta line with the Beta-Gamma line, had (at 2000 B.C.) a declination of +72°, situated at a distance of 18° from the north celestial pole; thus it would have just touched the horizon-line at 18° north latitude as it crossed the meridian. (This centerpoint of Ursa Major, the point of intersection of the Alpha-Gamma diagonal line with the Beta-Delta diagonal line, will be designated hereafter in this paper as "CP Ursae Majoris," see Fig. 4). The right ascension of CP Ursae Majoris in 2000 B.C. was approximately 87°, or 3° less than the summer solstitial colure which has a right ascension of 90°; another way of saying this is that CP Ursae Majoris made its meridian transit less than fifteen minutes before midnight of June 21, just touching the horizon at the latitude of La Venta as it made its lower transit. A century later, the meridian transit would have occurred almost exactly at midnight. It might be pointed out also that CP Ursae Majoris would cross the meridian at midnight again in its upper transit on the opposite side of the celestial pole on December 21, the winter solstice, 180° from its summer midnight transit.

Looking again at Fig. 9, it can be seen that directly south of Ursa Major, and squarely on the meridian, is located Gamma Cygni, the small center star of the constellation Cygnus. Fig. 5 shows the trapezium of this constellation whose diagonals conform roughly to the shape of an X. Gamma Cygni made its midnight meridian transit exactly on June 21st, having a right ascension of 270° in 2000 B.C Although this culmination was exact at 2000 B.C., it must be borne in mind that without clocks, "midnight" would only have been noted, perhaps, as the half-way point in time between sunset and sunrise, and a meridian transit would have occurred <u>approximately</u> at midnight for several centuries; in the case of Gamma Cygni, its culmination still took place around the time of midnight a thousand years later, in 1000 B.C.

Note the pattern that would have been seen on the night of the summer solstice, half-way in time between sunset and sunrise, in the second millennium B.C.: due north, just touching the horizon at 18° north latitude, the centerpoint of the bowl of the Big Dipper crosses the meridian; this constellation has moved down from the west to meet the horizon, then to rise and move an equal distance to the east by sunrise. The center of Cygnus, which was in the east after sunset, crosses the meridian at midnight, and by sunrise will have traveled the same distance west of the meridian as it was east of it at the beginning of the night. Thus the Big Dipper, a trapezium of four stars, has moved eastward, and Cygnus, also a trapezium, with a fifth star at the intersection of the diagonals, has progressed westward; both pass each other on the meridian at midnight going in opposite directions. Such an event would have been rather spectacular when occurring halfway through the night of the same day that the sun rose and set at its northernmost station of the year. It might also have been observed that on this day at noon the shadow of a vertical stick reached its shortest length of the year. Furthermore, a new season is now starting with its rains and budding vegetation.

The location of the sun on June 21, 2000 B.C., is shown in Fig. 9 by the usual symbol of the sun, a dot within a circle. At midnight the sun was 180° from Gamma Cygni, showing that both were on the same great circle. The meridian transit of each occurs 12 hours from the other; half-way in time between the successive midnight culminations of Gamma Cygni, the sun is on the meridian, and mid-way from one noon to the next Gamma Cygni crosses the meridian. If one wished to correlate solar and nocturnal events in order to begin a year count, the concurrent midnight meridian transits of the centerpoints of Cygnus and of Ursa Major, and the noon meridian transit of the sun on June 21 (the day it rose and set at its nothernmost point), would have had an obvious relationship, and thus would provide a convenient starting point for a year count. It might be noted that during those days of the year, the sun was "in" the sickle-shape of the constellation Leo; this constellation would not have been seen at all on that night, its midnight meridian transit occurring at the opposite time of year on the winter solstice, December 21. The midnight culmination of

Leo would have taken place half-way through the night of the day that the sun rose and set at its southernmost station; Leo would have had the same relationship to the winter solstice that Cygnus had to the summer solstice.

An observer anywhere in the northern hemisphere with a clear view of the sky at midnight on June 21, 2000 B.C., would have seen that Gamma Cygni reached the meridian at this moment. He would also be aware that almost due east, the Pleiades were rising above the horizon (Eta Tauri: $\alpha = 2^\circ.72$, $\delta = +5^\circ.23$). Almost due west, and directly opposite the Pleiades, the constellation Scorpio was setting on the horizon (Delta Scorpii: $\alpha = 185^\circ.98$, $\delta = -4^\circ.27$). The Pleiades would have been on the meridian approximately at midnight on September 22nd; the midnight culmination of Scorpio would have occurred March 21st. Thus Cygnus, the Pleiades, Leo, and Scorpio were four equidistant constellations whose midnight transits were concurrent with the summer solstice, autumnal equinox, winter solstice, and vernal equinox, respectively, each following the other by approximately 90° in right ascension. These facts are presented here for later reference, and also to note that these groups of stars had particular relationships to the path of the sun and to the seasons.

I think that the pattern of observations being made at La Venta at 1000 B.C. indicates that it must date back to a body of knowledge learned a millennium earlier, perhaps because agricultural activities in Mesoamerica demanded an accurate estimate of the length of a season. There is no evidence yet as to just where the earliest astronomical observations were being made, but the La Venta site and its art of 1000 B.C. seem to reflect a tradition based in large part on the meridian transits of stars occurring on the solstices and equinoxes around 2000 B.C. People living on elevated land which was not very distant from the sea would have been in a position to make these observations without any special apparatus. The main requirements would have been an interest in star movements leading to the comprehension that these conformed to an annual pattern. The obvious reason for developing a precise calendar, we assume, was to correlate dates and seasons with the advent or cessation of rainy periods, a knowledge which would have been very useful, perhaps indispensable, in slash-and-burn forest farming (Drucker and Heizer 1960; Heizer 1960). Wherever the earliest systematization of solar-stellar-calendrical-agricultural knowledge was effected, it was almost certainly not at La Venta which lies in an area of high canopy forest (for illustrations see West 1964: Fig. 3; Drucker, Heizer and Squier 1959: Pl. 2), possibly the Tuxtla Mountains were the scene of this early farming-calendar development (cf. Heizer 1968:24). When the Olmecs occupied La Venta the one thing they most needed was a vantage point of sufficient elevation to observe the true horizon, and here we seem to have the functional reason for the La Venta pyramid.

It has been noted that at 2000 B.C. the meridian transit of CP Ursae Majoris occurred approximately at midnight of June 21, and that it just grazed the horizon at the time of crossing. The picture a thousand years later was slightly different (compare Figs. 9 and 10). In 925 B.C., Beta and Gamma Ursae Majoris had exactly the same declinations (+68°.14), so that for more than a century before and after that date the "bottom" of the bowl of the Big Dipper would have been parallel to the horizon at the time it crossed the meridian. At La Venta, Beta and Gamma would have both set at an azimuth of 12° west of north, crossing the meridian below the horizon and lost to sight, then rising again 12° east of north. Alpha and Delta would have been continuously visible swinging across the sky just above the horizon line. Six hours before and after the meridian crossing, the bottom of the bowl of the Big Dipper would have been perpendicular to the horizon, due west and east of the celestial pole, respectively. In the millennium succeeding 2000 B.C., precession had caused right ascensions and declinations to shift, so that by 1000 B.C. CP Ursae Majoris made its meridian transit about an hour and a half after midnight (α = 116°). However, Alpha Ursae Majoris (χ = 98°), at the "edge" of the Dipper, reached the meridian going eastward only a half an hour after midnight, the same time that Gamma Cygni (α = 278°) also crossed it going westward. CP Ursae Majoris was now slightly further from the north celestial pole (δ = +71°), so that rather than just touching the horizon, it set into it at an azimuth of 8° west of north. I propose that the La Venta site complex was aligned to this setting azimuth of CP Ursae Majoris, because it had been learned around 2000 B.C. that its meridian transit and point of contact with the horizon occurred at midnight of the summer solstice, and in this way the solar year had been "keyed" to the sidereal year.

To sustain the theory, a few assumptions must be made. By the time of the construction of La Venta, the Olmecs must have had a fairly accurate knowledge of the length of the year, the solar and stellar movements, and the differences between solar, sidereal, and lunar counts. This must have included the ability to predict seasonal and nocturnal changes. Even without precise instruments and clocks, the cardinal points, for instance, could have been determined with accuracy, due east and west being the midpoint of the sun's journey north and south. "Midnight" would have been observed as the half-way point between the already known rising and setting points of a star along the eastern and western horizons, respectively. Similarly, "midday" was the midpoint of the sun's passage across the sky. Among virtually all the tribes examined in ethnographic studies of calendars of American Indians north of Mexico (Cope 1919:121-126; Spier 1955:16-30), the changing positions of the sun indicated the divisions of the day, while the movement of the major constellations and the morning and evening stars marked the night divisions. Apparently, because of certain ceremonials, it was often important to the Indians to recognize the divisions of the night. A relevant example is provided by the Californian Maidu, for in that tribe it was the role of the shaman to determine the period just before dawn, which he was able to discern by the position of the stars in the Dipper in reference to the north celestial pole. It seems likely that at La Venta the alignment to the setting point of Ursa Major was an expression of a cultural focus on that constellation via a long-practiced tradition of its being predominant and of prime importance in the night sky, even though at this date the meridian transit of the center no longer correlated exactly with the June solstice. Indeed, one can even imagine an important annual rite being performed in this connection, perhaps to celebrate or ensure success in the new season or year.

It is interesting to note that in the millennium between 2000 and 1000 B.C., precession had caused the declinations of the stars in Ursa Major first to rise and then to fall slightly. The figures listed below give the comparative declinations of Alpha, Beta, Gamma, and Delta Ursae Majoris between 2500 and 500 B.C.:

Years B.C.	Alpha	Beta	Gamma	Delta
2500	+71°.08	+67°.40	+70°.66	+75°.16
2000	+72°.48	+68°.32	+70°.55	+74°.99
1500	+73°.22	+68°.61	+69°.77	+74°.02
1000	+73°.22	+68°.25	+68°.39	+72°.42
500	+72°.47	+67°.26	+66°.52	+70°.32

It can be seen that the declinations of Alpha and Beta rise until 2000 B.C. and then become fairly stable for the next thousand years; in the 500 years following 1000 B.C., their declinations drop almost a whole degree. The declination of Gamma decreases throughout the time span, but the change is almost imperceptible until 1500 B.C.; then it falls by more than 3° between 1500 and 500 B.C. The pattern is similar for Delta, decreasing 1° in the first thousand years, and almost 4° in the succeeding thousand (1500 - 500 B.C.). Declinations of all four stars decrease twice as fast in the 500 years following 1000 B.C. as in the preceding thousand years (2000 - 1000 B.C.). Since the increase or decrease in the declinations of the four stars are not synchronized with each other, the declination of CP Ursae Majoris remains fairly stable, acting as a sort of pivot around which the four stars shift. Between 2000 and 1000 B.C. the declination of CP Ursae Majoris decreases only by one degree. However, after that date, since the declinations of Alpha, Beta, Gamma, and Delta decrease simultaneously, the declination of CP Ursae Majoris also begins to fall twice as fast as before, lowering by a whole degree in the next 500 years. By 500 B.C. even Delta Ursae Majoris would have been setting into the horizon at latitude 18° north. Alpha Ursae Majoris following suit by 300 B.C., with the result that by this time all four stars (the entire bowl of the Big Dipper) would have been briefly lost from view when it crossed the meridian in its lower transit.

Let us suppose that if early Mesoamerican peoples had begun to observe Ursa Major rather carefully, what must have appeared to be mysterious changes in its position in the sky were occurring just about the time at or immediately prior to the building of the Phase I structures at the La Venta site. Interestingly enough, the constellation would have appeared to sink lower and lower at an increasing rate after construction of the complex, and by 600 B.C., the estimated date of the abandonment of the site, Ursa Major was dipping much lower below the horizon than formerly, now having a setting azimuth of almost 10°. Due to precession, by 600 B.C. the midnight meridian transit of CP Ursae Majoris, or even of Alpha Ursae Majoris, would have been seriously out of step with the solstices. At that date Alpha Ursae Majoris had a right ascension of 109°.64, meaning that it would have crossed the meridian about an hour and 20 minutes after midnight; CP Ursae Majoris would have made its meridian transit two hours and 20 minutes after midnight. Furthermore, it will be recalled that at 1000 B.C. Alpha Ursae Majoris and Gamma Cygni crossed the meridian at the same moment (about a half an hour after midnight); by 600 B.C. Alpha Ursae Majoris preceded the culmination of Gamma Cygni by more than a half an hour.

The theory, then, suggests that the orientation of the La Venta site was based on a keen interest in Ursa Major and the implication is that the constellation was very important to the Olmecs, presumably for calendrical reasons. Although they probably had a good knowledge of the motion of the sun and stars and length of the year, they could hardly have understood the principle of precession, and might well have been curious, perhaps disturbed, about the shifting position of Ursa Major, both because, after having been comparatively stable for a thousand years, it appeared to be dropping lower in the sky, and also because its midnight culmination was changing in relation to the solstices; in addition, the time of meridian transits of CP Ursae Majoris and Gamma Cygni were occurring further and further apart. If such was the case, it would seem that by 600 B.C. (the calculated date of abandonment of La Venta) the site had accomplished the purpose for which it had been designed, and it is clear that the alignment was no longer so precisely oriented to the setting azimuth of CP Ursae Majoris as it had been 400 years earlier. The intention is not to argue the above as a cause of abandonment, but only to suggest it as a possible factor in the cessation of the site.

Further support for the astronomical basis of the orientation of La Venta appears to be offered by certain elements of the symbolism in Olmec art, which is expressed in carved stone in the form of "stelae," large "table-top altars," colossal human heads, small jade figurines, and plain and incised stone celts. A prominent motif in the iconography is that of the anthropomorphic jaguar which is most frequently portrayed as a conventionalized face with "snarling," exaggerated, squared upper lip and flattened head, often with a V-shaped cleft at the center (Figs. 15, 16, 23-26, and Fig. 39). The "altars" and "stelae" often have an open arch ("niche"), sometimes suggesting the open jaws of a jaguar, which contain seated or standing human figures; these frequently hold what appears to be a human infant whose face has some of the stylized jaguar features (Figs. 18, 19). Faces carved both in the round and incised on objects depict the conventionalized jaguar mask, or show human faces with feline attributes; they appear full-face as well as in profile, sometimes combining the two positions (Figs. 17, 22). Often the jaguar wears an X ("crossed bands") symbol on his head or chest (Figs. 14, 15, 20, 35 and Fig. 39a).

One does not have to stretch one's imagination very far to realize that the squared and exaggerated upper lip of the jaguar is very like the shape of the bowl of the Big Dipper. Furthermore, the lip may be represented as a carved or incised line connecting four drill holes placed in the positions of the four stars (see Fig. 35 and especially 37). The implication seems to be that this important constellation represented a jaguar deity which was possibly worshipped for his celestial and/or seasonal (agricultural) role. This suggestion is strengthened by the fact that among the historic Nahua of Mexico, Ursa Major was actually called "Ocelotl," which translates into "tiger" or "jaguar" (Brinton 1893:56; Förstemann 1904: 568). In the Annals of Cuautitlan, the nocturnal sky dotted with stars was conceived as a jaguar skin with spots (Brinton, loc. cit.). It may have been that anciently the jaguar stood for the night sky, the four stars of the Dipper forming his trapezoidal mouth. According to Thompson (1950:74), among the Aztecs the jaguar symbolized night, or night sun, and the interior of the earth (darkness); he believes this was the case for the Maya as well. The idea seems to be that as the sun determined the passing of days and the solar year, Ursa Major played an analogous role as the "night sun", measuring the sidereal year. For the Maya, the jaguar had a connotation of nobility or leadership with prestigious authority; one might guess that the association derives from its supreme role and dominant position in the sky.

It is interesting also to recall that in the Aztec myth of the Five Suns concerning the five creations and subsequent destructions of the world, the first creation is attributed to Tezcatlipoca who transformed himself into the sun. When Quetzalcoatl knocked him out of the sky, Tezcatlipoca in a fit of rage turned himself into a jaguar and destroyed the earth (Bray 1968: 153). The Annals of Cuautitlan give the name "Ocelotonatiuh" (Son of Jaguar) to the first creation (Armillas 1945:38-39). Among the Aztecs, Ursa Major mythically represented the god Tezcatlipoca deposed from his position as the sun god, falling into the sea (Brinton, loc. cit.). The idea is presented here as no more than a suggestion, but it all can be interpreted as a latter day recollection of the increasing distance between Ursa Major and the celestial pole in the first millennium B.C., when precession was causing the constellation to sink lower and lower into the horizon, and hence the jaguar was seen to "fall" from the sky into the sea.

If the stylized mouth and lip of the jaguar was seen as representing the bowl of the Big Dipper, it is further possible that the cleft in his head symbolized the meridian, since the cleft seems to mark the central axis of the figures, as the meridian divides the sky into two equal halves. CP Ursae Majoris seemed to have functioned as the "pointer" of the Dipper, its midnight meridian transit possibly serving as the starting point. The position of CP Ursae Majoris with respect to the meridian would have provided a useful measuring device, its journey again back to the midnight transit providing both a nightly and yearly "clock."

Since Ursa Major revolves about the celestial pole, the hour or season can be determined by its location in the sky (hour angle); this may explain the portrayal on some Olmec carvings of faces incised in profile and which either face east, west, or north,[7] superimposed on the full front view (Figs. 17, 22). That is to say, the direction to which the incised jaguar profile is turned may indicate where the constellation is in relation to the pole. If viewed at the same hour nightly throughout the year, particular positions would correlate with each season. It will be recalled that ca. 1000 B.C. at six hours before and after its meridian transit, the bottom of the bowl of the Dipper was perpendicular to the horizon, a fact which would relate quite well to the profile rendering of the jaguar face. That is to say, if the lower transit at midnight of CP Ursae Majoris was related to the summer solstice and the midnight upper transit to the winter solstice, then the halfway points, due east and west of the north celestial pole (where the Dipper would have been seen to lie "sideways,") would correlate with the equinoxes and the profile views of the jaguar face. Around midnight of September 22nd, Ursa Major would have been situated east of the pole, and on March 21st, it would have been west of it. Often these profile views show the cleft at right angles to the profile (Fig. 17), possibly to indicate that CP Ursae Majoris is 90° from its meridian transit.

A tentative note might be added here as an explanation for the frequent theme of a human figure holding an infant with feline attributes. Such a theme may carry the meaning of "beginning" or "birth" of a new year or season, or perhaps "new sky" in reference to starting the year count. It seems especially appropriate for the onset of the summer season with its accompanying rains which bring a renewal of life and growth. It is conceivable that the new season or year count was considered to have begun as the constellation emerged from the horizon on the night of the summer solstice.

An important motif appearing with the jaguar is the X, or "crossed bands," sometimes called a St. Andrew's Cross. It is often worn on his forehead, as a chest ornament, or at times in the eye (Figs. 14, 15, 20, 35). On the assumption that there is an astronomical basis for the symbol, we can suggest that the motif represents the constellation Cygnus. It can be seen in Fig. 5 that the constellation easily lends itself to the configuration of a cross, of which Gamma Cygni is the center. Even though Beta Cygni lies at a greater distance from Gamma than do Alpha, Delta, and Epsilon, the intersection of the two diagonal lines is a fixed point at Gamma. It was already pointed out that around 2000 B.C. Gamma Cygni was precisely on the meridian at midnight on June 21st. It is possible that Gamma Cygni was the object of focus on that night, and then the other brighter stars of Cygnus were seen in relation to it, Alpha, Beta, Delta, and Epsilon Cygni forming the crossed diagonal lines of which Gamma was the center; CP Ursae Majoris, north of Cygnus and on the meridian, was also conceived in terms of crossed diagonal lines drawn from the four stars forming its trapezium. The resulting pattern was to become fixed into a conception that endured for centuries. I think the evidence shows that the sky was organized into such a conceptual pattern by the Olmecs, and that therefore it was logical for them to orient their site to the centerpoint of the Dipper as it set on the horizon at 1000 B.C. (cf. p. 10, paragraph 2).

To lay aside the argument for a moment, one might speculate on how early Mesoamericans might have made their astronomical observations. Spinden (1924: Fig. 24) and Morley (1956:258) reproduce representations of simple observatories in the Mexican codices. The Codex Nuttall shows a pair of crossed sticks in the doorway of a temple; the head of a man is portrayed looking through the crossed sticks. In the Codex Selden, a pair of crossed sticks sppears in the temple doorway, with an eye in the notch. In the Bodleian Codex, an eye between two crossed sticks is shown, with a star descending into a notch and with two observers seated at either side. If the use of crossed sticks for making stellar observations was extremely ancient, it could account for the reason why Cygnus and Ursa Major were perceived in terms of crossed diagonal lines. If they were observing the meridian transit of Gamma Cygni, for example, it might easily occur to them that the other four stars lay approximately at the ends of their sticks when Gamma was centered between them.

The particular alignment, along a great circle, of Gamma Cygni, the north celestial pole, and the pole of the ecliptic in the first three millennia B.C., caused that star to display a remarkable stability (compare Figs. 11-13). Its declination between the year 3500 B.C. (δ = +34°.51) and the year 500 B.C. (δ = +34°.53) did not exceed by one degree the minimum value reached in 2000 B.C. (δ = +33°.55), due to its particular location in reference to the pole of the ecliptic. Gamma Cygni had an important relationship to the sun during the same time period: its midnight culmination coincided exactly with the summer solstice in 2000 B.C. (χ = 270°). These facts together indicate that Gamma Cygni makes an excellent candidate for a calendar star at that time. The evidence in Olmec iconography seems to confirm that those people observed Ursa Major throughout the night and year, but that the passage of Cygnus was an important signal within the perennial circuits of the Dipper.

The right ascension of Gamma Cygni in 1000 B.C. (278°) indicates that this constellation more accurately heralds the June solstice than does Ursa Major, since the former was still centered on the meridian fairly soon (about a half an hour) after midnight, whereas by this date CP Ursae Majoris does not make its transit until more than an hour and a half later ($\chi = 116°$). Similarly, the evidence in Olmec art seems to indicate that the jaguar wears the crossed bands symbol in connotation of the summer solstice.

A problem arising here is differentiating the crossed bands symbol as referring to Cygnus, or to Ursa Major which also may be represented by the symbol. There does, however, appear to be a difference between the two. The distinction seems to be that when Ursa Major is represented, the crossed bands symbol is wider (i.e., flatter) than it is high. When the symbol is more equilateral or taller than it is wide, often in conjunction with a zig-zag motif, the meaning of Cygnus is conveyed. Both types appear in Fig. 20 on the chest of the figurine, Ursa Major beneath the chin, and Cygnus below it. The meaning in this case would seem to be that both constellations cross the meridian at midnight (or nearly so, having this relationship by tradition). An interesting point is that Fig. 20, a drawing of the infant held by the Las Limas figure (Fig. 40), recalls the idea presented earlier that the theme of holding forth an infant referred to the summer solstice. Note also the four stylized profiles (Fig. 21) incised on the shoulders and knees of the main Las Limas figure. What may be represented are the four "aspects" of the jaguar deity, or night sky (more specifically Ursa Major in the night sky), each relating to one of the four seasons or quarters of the year. On the night of the summer solstice, the count of the year begins, the infant conveying the association of "new" or "beginning."

Fig. 14 and Fig. 39a also show the crossed bands of Cygnus, similar in shape to the same element worn by the infant in the Las Limas sculpture; all three cases are accompanied by the zig-zag motif. Fig. 18 (La Venta Altar 4) shows a flattened cross within the mouth of the jaguar, and in this case the reference seems to be to Ursa Major. The zig-zag motif is not present, and the figure in the niche does not offer an infant. The seated personage in the niche on La Venta Altar 5 (Fig. 19) holds an infant in his arms; the man wears a headdress which has on the lower rim the equilateral crossed bands (Cygnus) placed to either side of a jaguar face. The interpretation in this case would be that Cygnus goes from one side of the sky to the other, passing Ursa Major; it is the night of the June solstice; the infant is present.

It is not as clear which constellation is meant by the crossed bands worn by Fig. 15. The shape is more like the symbol when used for Ursa Major; however, he wears the same type of ornament over his ears as the Las Limas infant. The M-shaped motif (noted hereafter as "M-Element") on his headdress is seen again in Figs. 28, 32 and on the celts in Fig. 33. A similar type of representation is seen on Fig. 16. A guess is that the central cleft in these figures denotes the meridian, and that the M-Element to either side of it depicts the location on the horizon (perhaps sighted over a marker) where CP Ursae Majoris dips into it and then emerges after crossing the meridian. The theme is re-emphasized on the rim of the headdress on Fig. 15 where on the left a line slants down to the center (meridian); on the right a line slants upward from it. Fig. 32 and also the celts in Fig. 33 show the same idea; a cleft and center line with the M-Element to either side. The four dots in these cases may represent Alpha, Beta, Gamma, and Delta Ursae Majoris, the whole signifying the meridian transit of the constellation.

Not to be overlooked are the two mosaic "jaguar masks" found at La Venta (Fig. 31). These were buried in deep pits beneath two rectangular brickwork platforms, one on either side of the centerline of the main complex, north of the great pyramid (Drucker, Heizer, and Squier 1959). Each mask is identical to the other, and both were made at the same time. Each consists of serpentine blocks arranged in a 15 by 20 foot rectangle. The whole is once again a development on the theme of matching units bisected by a centerline, above which is shown a bar with three protruberances, possibly a modification of the M-Element. The masks themselves flank a central line, the main north-south axis of the complex. Further north, centered on the main axis, lies a third buried mask, which has the same pattern as the other two, but is formed in the reverse method; the serpentine blocks compose the M-Elements on the blank space of the main rectangle. Note the pattern as it would have been observed from the pyramid. The four stars forming the trapezium of Ursa Major descend from the west to dip into the horizon, cross the meridian, then rise above the horizon again an equal distance on the other side; these three steps comprise the meridian transit of the constellation. The two platforms covering the jaguar masks, and bordering the main axis from the pyramid, repeat the pattern of centerline and rectangle (analogous to the trapezium of Ursa Major) to either side of it. Each mask itself reflects an axial arrangement, the cleft at the centerline dividing the matching halves, each containing two smaller rectangular units. The M-Element re-emphasizes the pattern of a centrally divided motif, and each of the four units below once again reiterates the theme, being themselves designed as small M-Elements. The development and variation-on-a-theme was conveyed by the La Venta artist from the main object of focus from the pyramid, the setting of Ursa Major, to the smallest detail of the masks below it which seem to be a geometrical idealization of the spectacle. The four "tassels" at the base of the masks may have represented the four seasons, or quarters of the year.[8]

Incised Olmec celts from the La Venta site and from unspecified sites show no signs of utilitarian use as work-axes or common cutting instruments. We can assume they served primarily for ceremonial functions. It is tempting to think that perhaps they were used as some sort of sighting devices or as markers used for astronomical purposes, and that the designs incised on them related to their observations. Other celts are more elaborate than those shown in Fig. 33, some appearing to bear a "text." In Fig. 35 the four circles representing Ursa Major frame his mouth. In the center of the mouth is a square notch, marking the meridian. The crossed band motif at the center of the headband refers to Cygnus on the meridian, the three "droplets" above perhaps indicating the rains associated with the summer solstice. Each eye has the "flame" eyebrow in which a square notch can be discerned, and this may represent the location or mark on the landscape where Ursa Major dips into and out of the horizon on either side of the centerline. The square notch at the mouth and above each eye is therefore analogous to the M-Element. In the left eye appears the crossed diagonals of CP Ursae Majoris, the right eye contains an irregular line. Conceivably, what is meant is that Ursa Major is setting as Cygnus crosses the meridian, the right eye showing the horizon east of the meridian where Ursa Major is not yet apparent. Such would have been the case in the first millennium B.C. when Cygnus culminated on June 21. It seems significant, and cleverly rendered, that the artist has here combined several concepts relating to "eye": the eye of the observer, the object of his attention (i.e., a point on the horizon), both expressed within the eye of this stylized face. The four cleft elements on the headdress may refer to the four seasons, meaning that CP Ursae Majoris (the "pointer" of the Dipper) had four different positions with reference to the meridian at the time of the solstices and equinoxes. The design on this celt is reminiscent of the buried mosaic masks at La Venta: both contain references to the setting of CP Ursae Majoris expressed by the M-Element concept, and each also contains an association with a line of four repeated units, presumably indicating the four seasons, the four critical times or stations in the year count.

It might be noted at this point that the incised design (Fig. 22) on the face of the Las Limas figure also contains a line of four cleft elements on the forehead. A face in profile can be discerned on either cheek, perhaps to indicate the position of Ursa Major at the equinoxes. At the base of the chin a cleft rectangle is shown, the cleft being at the left side of it. Another cleft appears immediately above the rectangle at the center of the chin. To the left of this cleft is shown what may be a closed eye (upside down); to the right of the cleft there appears to be an open eye (right side up). The meaning would seem to be that CP Ursae Majoris sets into the horizon coming down from the west ("upside down") and cannot be seen; the right eye shows that it rises again (becoming "right side up") and is visible again. Hence the face seems to reveal the circumpolar route of Ursa Major, strengthening the idea proposed earlier (p. 18) that the figure carries the meaning of the night sky, holding the infant in connotation of the summer solstice. The two circles on the upper lip and the two drill holes at the corners of the mouth portray the stars comprising the bowl of the Dipper. The line of four cleft units on the forehead, each containing the M-Element, probably convey, as in the previous examples, the meaning of "four times a year," or the four seasons. These four units can also be discerned on either side of the face (two on each side) in conjunction with the profiles. The cleft profiles on the shoulders and knees of the Las Limas figure (Fig. 21) may be the personified versions of the sky in the four seasons, as has already been mentioned.

Before continuing with the subject of Olmec celts, it is necessary to discuss another theme that frequently appears in Olmec art, that of a figure with the conventionalized down-turned mouth holding a crescent in one hand, and a torch-shaped object in the other (Figs. 25, 26, 29, 30). The "torch" in Figs. 26, 30 resembles a bud, or budding vegetation. The crescent held by Fig. 26 seems rather like the shape of a sickle; it appears in like manner in Figs. 25, 29 and also Figs. 23, 24 where the person holds this object (often termed "knuckle duster") in each hand. It seems possible that the budding vegetation conveys the meaning of June and the advent of the rainy season. The corresponding object held by Fig. 25 does not resemble vegetation, but looks, instead, like the M-Element described above and proposed as signifying the setting point on the horizon of CP Ursae Majoris. Thus the object conveys the same meaning that budding vegetation does, i.e., the summer solstice.

Since the torch-shaped object seems to be shown in opposition to the crescent-shaped object (for the two are repeatedly shown as a pair), it seems logical that the crescent must carry the meaning of something either equal to, or opposed in concept to, the summer solstice; this would be the winter solstice. It can be seen in Fig. 9 that 180° from Cygnus (in 2000 B.C.), and at approximately the same declination, is located the "sickle" of the constellation Leo. It was pointed out earlier that this constellation would not have been visible on the night of June 21; likewise Cygnus would not have been seen in the night sky of December 21. On that night in the era between 2000 and 1000 B.C., the sickle of Leo would have culminated at midnight. Thus it is clear that Leo in winter was counterpart of Cygnus in summer. One might surmise that in Figs. 23, 24, and 34, where a crescent is held in each hand, the portrayal is to be understood as the winter solstice when Leo moves an equal distance from east to west, crossing the meridian at midnight.

To conclude this partial and selective iconographic interpretation of Olmec art, three more celts will be discussed. The proveniences of two of them are not known, but both contain undoubted Olmec elements. The first of these, known as the Humboldt Celt, was presented early in the 19th century to Baron Alexander von Humboldt by Sr. Andres del Rio, Professor of Mineralogy at the School of Mines in Mexico. Humboldt deposited it in the royal cabinet of the King of Prussia in Berlin, from whence it was transferred to the Königliches Museum für Völkerkunde, Berlin. In 1904 a cast of the celt (with the tip now broken off) was deposited in the Smithsonian Institution in Washington, D.C. Since World War II (presumably as a result of aerial bombardment) the original specimen in Germany has disappeared, but a drawing taken from Humboldt's notes is given by Penafiel (1890: Pl. 119). Combining this drawing with the reproduction of the broken cast, a complete reconstruction of it can be made (Fig. 36).

The Humboldt Celt is important to this analysis, because if the theory presented here is correct, i.e., that Olmec iconography contains elements reflecting the pattern of the night sky ca. 2000 B.C., the text of the celt can be "read." The interpretation (following the numbers in the diagram) is as follows:

1. Crescent, representing the constellation Leo. It is very similar to the crescent held by Fig. 30. If the observer were facing the northern horizon, his eye moving southward along the meridian, the bright star Antares would be seen at the "top" of the crescent, as the large circle appears at the top of the crescent here. Below, two hands are pointing. The first one points to the west (to the right side of the page). The meaning is that Leo is "over there," i.e., has already set in the west. An interesting thing about this celt is that it presents a "mirror-image" of the sky, either by holding it upright so that the design faces the northern horizon, or by laying it on a flat surface so that the lower end points toward the north. Hence the right of the celt (as viewed by the reader) coincides with the west, and left of it with the east. The base of the celt correlates with the horizon line, the top of it with a point close to zenith.

2. The Pleiades, here represented as a cluster. The second arm and hand beneath (pointing to the left side of the page) indicates that the Pleiades are in the east. Ethnographic evidence indicates that one of the Aztec names for this constellation was "miec," meaning "heap," and that they attached ceremonial importance to the zenith passage of the Pleiades at the end of a 52-year cycle (Seler 1904:357). This may indicate an ancient tradition of watching for it, which then became ritualized and which persisted after its appearance no longer correlated with the seasons. Bishop Landa (Tozzer 1941:132-133) states that the Pleiades was one of the constellations used by the Maya of Yucatan as a "guide by night, so as to know the hour."

3. An eye, the Pleiades, and a hand pointing to the left. The meaning is: "The Pleiades become visible in the east." The "comb" elements surrounding the eye may be related to the Maya "count" symbol. According to Thompson (1950:44), in Maya hieroglyphic writing the comb form of the "count" affix can be replaced by the head of the mythological xoc fish; both correspond to the Maya word xoc, "count" or "sum." He also argues that there is an obvious connection between the two forms of the "count" glyph and water.

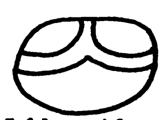
4. The crossed bands of Cygnus. The X is higher than it is wide, and is flanked by the three "droplets" on either side which also occur in connection with the crossed bands on the celt in Fig. 35, and also on the headdress of the figure holding the infant on La Venta Altar 5 (Fig. 19). It was noted that the droplets may refer to the advent of the rainy season in connection with the midnight culmination of Gamma Cygni on June 21.

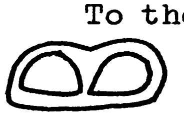
5. Conjoined index finger pointing east and west, indicating that Gamma Cygni is at the center, on the meridian, traveling the length of the sky during the course of the night. The element immediately above No. 5 appears to be the zig-zag element that occurs elsewhere in conjunction with the crossed bands symbol. The meaning of the zig-zag is not clear, but seems to be definitely associated with Cygnus. It may be affiliated with the zig-zag motif appearing on the "budding vegetation" held

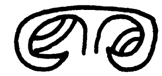
by Figs. 26 and 30, and if so, the association would be with the summer solstice and new growth, perhaps "beginning" of the count of the year.

6. An element which may mean something like "the year divided into four quarters (seasons)," namely, the solar year. The sign, known in Maya epigraphy as the Kan cross, is also worn by Fig. 30 as ear ornaments. The four small round circles at the exterior of each quarter of the Kan cross on the Humboldt Celt may represent the sun during each season, a period of time determined by its course north and south. This solar year sign appears directly below Cygnus which is centered on the meridian at midnight, associating the year with the summer solstice and the onset of the rains.

To the right of the year sign is a unit which I believe is meant to represent the autumnal equinox. A motif appears here which resembles vegetation (perhaps "blossoming" or "in fruit"). The association may be with the harvest, or middle of the rainy season; September 22nd comes in the heart of the wet season which generally continues from June to February. Part of this symbol appears again on the next celt to be discussed, and it will be argued that it represents September in that case as well. It will be remembered that this side of the celt denotes west, the side where the sun sets. On the autumnal equinox, Cygnus would have been on the meridian at sunset.

Below the year symbol, the element  appears superimposed on the crossed bands. This element is very like the Maya glyph Akbal, meaning darkness. In December, at the time of the winter solstice, Cygnus is not visible during the night, therefore it may indicate that Cygnus is "dark."

To the left of the Kan cross, or solar year symbol, is shown the element:  It seems to be superimposed on the lower or upper half of the crossed bands symbol; since this unnamed symbol looks like the upper half of the Akbal sign, it might be possible to say that the upper half of Cygnus is meant. This is the east side of the celt, where the sun rises. On the vernal equinox (March 21), Cygnus is on the meridian at sunrise, having risen sometime before midnight. Thus Cygnus is visible for half of the night, the symbol telling us "Cygnus half visible, on the meridian when the sun rises," indicating that it will be seen during the "upper" (later) half of the night, towards morning.

All four of the seasons rest on the symbol:  Here the meaning is even less certain, but the half-circles at each side of the main element seem to be similar to the circle at the top of the crescent which was interpreted as the bright star Antares. It may be that the symbol carries the meaning of stars rising and setting, i.e., the night sky. The two concentric circles may mean even more specifically "bright" star. The symbol will be referred to again on the next celt, but note that the Pleiades cluster does not show the concentric circles, each circle having only the single outline. The Pleiades, though a conspicuous cluster, is made of small, faint stars. Note also that above the first hand that points to the west, in reference to Leo, the curved element above the finger does not contain the concentric circles. The intention may be to show that the stars of Leo will not rise and set on the night in question (June 21). The small plain circles around the Kan cross would not be confused with stars, because that symbol refers only to the sun and the solar year.

7. The meaning of this design is the least clear of all. A tentative suggestion is that it is a representation of the sighting line from the observer to the meridian. The lines leading directly to the central axis would seem to mean that the center of the sky (meridian or north-south axis) is the focus. Another interpretation is possible. If the celt is not meant to present a mirror-image of the sky, but to illustrate the sky as one faced south holding and reading the celt in front of him, this particular sign may then indicate something like "turn (invert) celt" or "turn celt around (and face north)." Nos. 8 and 9 below would then still be correctly read to identify the constellation on the northern horizon.

8. A shape representing the bowl of the Big Dipper.

9. The horizon line, showing by the notches that the Dipper sets and then rises again on either side of the meridian, similar to the concept of the M-Element. It seems likely that the celt tells of the sky ca. 1000 B.C., that "midnight" is only an approximation, when the Dipper would have

set into the horizon very briefly at or near latitude 18° north. "Sunset" and "sunrise" are also only approximate, for there is a duration of an hour or so when the sky is gradually getting darker or lighter.

10. Digging stick. The left side of the celt is associated with east, sunrise, and the vernal equinox, with the accompanying dry season. The soil is cultivated at this time and planting occurs in April or early May (Morley 1956:134; Long 1948:215), to coincide with the first rains.

11. Some type of cutting implement. This side of the celt is associated with west, sunset, the autumnal equinox, and the accompanying rainy season. The cutting of the brush (to be burned in the dry season) is done at the height of the wet season (Morley 1956:130). This tool has been interpreted as an "atlatl," (Beyer 1969:422), but the resemblance is not convincing. Its appearance is much more like that of a cutting implement.

The Humboldt Celt is an interesting combination of Olmec and what seem to be Maya elements and contrasts to the other celts discussed here in this respect. Its context appears to be a star map which is surprisingly similar to that shown in Fig. 9, the objective of which seems to be to record the correlation of the solar year with the sidereal year. The subject matter deals with a pattern in the night sky (keyed to the rising of the Pleiades and the meridian transit of Gamma Cygni) and the hour it would have been seen at four distinctive times in the year measured according to the path of the sun, the correlation being most accurate between 2000 B.C. and 1000 B.C. One supposes (in default of any information whatsoever as to its provenience and age) that it was a copy of something which had been learned and perhaps inscribed in a simple way at a much earlier date. The main emphasis is on Cygnus, or more precisely, Gamma Cygni, which has already been shown to have been very stable and well-qualified as a calendar star. It can only be guessed as to why it presents a mirror-image of the sky; certainly the reversal of east and west with respect to north must have had some ceremonial or astronomically-related use. That is to say, the celt must have functioned in some way so that its position rendered the directions pointed to in the design capable of showing where the sun rose and set.

The discussion of the celt in Fig. 37 will also follow the numbers on the diagram:

1. Cleft elements, pointing to north, east and west. They probably refer to CP Ursae Majoris functioning as a pointer in relation to its position in reference to the meridian in each of the four seasons of the year. East and west do not seem to be reversed on this celt, and it does not present a mirror-image of the sky.

2. Cygnus, with Gamma Cygni at the center on the meridian.

3. The four stars of the Dipper, framing the mouth of the stylized jaguar in profile view. It will be recalled that six hours (90°) before and after its meridian transit the Dipper was perpendicular to the horizon, and therefore it was postulated that the profile view was related to the position of Ursa Major at the equinoxes. The stars forming the mouth are represented by concentric circles, perhaps to indicate that they are bright stars; Gamma Cygni, which is a small, faint star, is shown as a single circle.

4. This is an element similar to that on the Humboldt Celt (Fig. 36) on the right side of the Kan cross (No. 6) and interpreted as the autumnal equinox.

5. Vegetation symbol, similar to that held by Fig. 26. Note the zigzag motif which seems to correspond to the budding aspect, or new growth connected with the summer solstice.

6. Crescent, similar in general outline to that on the Humboldt Celt (Fig. 36, No. 1) and also held by Fig. 30. The object is related to the sickle of the constellation Leo, and represents the winter solstice.

7. Hand, pointing to the east. At the base of the hand is shown an eye on the horizon. The hand may relate to the cleft "pointers" at the top of the celt, in which case the direction would be read as "CP Ursae Majoris, east." The bowl of the Dipper will be observed to rise above the horizon and will remain east of the meridian throughout the night, being perpendicular to the horizon midway in its journey. Cygnus will be on the meridian

after sunset, moving east during the night. The season is halfway between the summer and winter solstices, indicated by the budding vegetation on the left (west, or setting side), and the crescent of Leo on the right (east, or rising side). A tentative suggestion for the design on the hand is that it shows a doorway or platform over which the Dipper will be seen to rise.

If this analysis has any basis in fact, it is significant that the two celts deal with the same subject, the seasonal locations of Ursa Major and Cygnus; one deals with all four seasons focusing on Cygnus, the other primarily with the autumnal equinox emphasizing Ursa Major. They seem to refer to the sky around 1000 B.C., but reflect meridian transits coinciding more accurately with the solstices and equinoxes around 2000 B.C. It may be that they represent copies of earlier examples (perhaps inscribed on wood) from which stellar change was measured, and by which calendrical computations were made. In this way the actual difference in the length of the sidereal year, as compared with the solar year, could have been estimated. By the time the Maya were erecting stelae early in the first millennium of the Christian Era, knowledge of this sort was very accurate. The engraved celts referred to here may also have been "textbooks" or pictorial teaching devices recording astronomical data in symbolic form, i.e., glyphs. Astronomer priests could have employed them in communicating their special knowledge; at least they would have been highly suitable for such a purpose.

The third celt (Fig. 38) also deals with the same subject matter as those above, but in a slightly different manner. It is especially significant because it was actually part of a cache deposit at La Venta which was recovered by controlled excavation (Drucker, Heizer, and Squier 1959:135-146). Thus its provenience and approximate age are clearly relatable to the Olmec at the time of their occupation of La Venta. The interpretation (following the numbered motifs) is:

1. The crossed bands of Cygnus, the X being higher than it is wide. The center corresponds to Gamma Cygni on the meridian.

2. The Kan cross, or solar year with its four seasons. Both the Kan cross and the crossed bands of Cygnus are present on the Humboldt Celt

(Fig. 36, nos. 6 and 4, respectively). Here the superposition of the one over the other may be intended to convey the idea of a simultaneous correlation of the solar year and its seasons, with the sidereal year measured by the meridian transits of Gamma Cygni.

3. Ursa Major, identified by the cleft which indicates that CP Ursae Majoris is the object of focus in the constellation. CP Ursae Majoris descends from the west, dips into the horizon, and crosses the meridian (the central axis of the celt, in line with the center of the crossed bands). The fact that west is on the left of the celt, east on the right, shows that the design does not present a mirror-image of the sky as with the Humboldt Celt.

4. The M-Element, already argued as relating to the setting of CP Ursae Majoris on the horizon. Ursa Major is shown partially superimposed on it.

5. Possibly this element represents Gamma Cygni moving to the west. Note that the vertical line from which it is drawn is continued above Ursa Major to the top of the celt, and this line is to one side of the central axis of the celt, or meridian. This may be done deliberately to indicate that Gamma Cygni and CP Ursae Majoris did not pass each other while crossing the meridian, as they did in 2000 B.C. If this is the case, the implication is that the celt was designed at the time of the occupation of La Venta (ca. 1000 B.C.), a supposition which seems probable in any case. At this time Gamma Cygni and CP Ursae Majoris pass each other well after midnight; however, Alpha Ursae Majoris, at the "edge" of the Dipper, and Gamma Cygni reached the meridian at the same time, shortly after midnight. The front edge of the cleft element (3), denoting the edge of the Dipper, is in line with the center of the crossed bands, the central axis of the celt. Probably the Olmec astronomers knew that at an earlier date CP Ursae Majoris and Gamma Cygni had crossed the meridian simultaneously at midnight of the summer solstice. It was now apparent that Alpha Ursae Majoris and Gamma Cygni culminated at the same time; it cannot be stated with certainty whether or not they were aware that this culmination was no longer precisely halfway through the night of June 21 (occurring only about a half

an hour after midnight in 1000 B.C.). It seems possible that they might have still considered the midnight meridian transit of Gamma Cygni to herald accurately the summer solstice but that it was quite obviously no longer the case for CP Ursae Majoris. The design of the celt seems to indicate their interest in the difference in time between the two transits which they were observing at that time and perhaps measuring.

6. This seems to be an eye, and the entire design on the upper half of the celt may represent a highly conventionalized face in profile. A rather similar type of stylized profile was seen on the celt in Fig. 37. An implication may also be that the eye of the observer is directed toward the setting of CP Ursae Majoris on the horizon; this connection with the eye on a face has been seen earlier on the celt in Fig. 35.

In summation, all the celts seem to deal with the same subject: the pattern of the night sky with emphasis on the constellations Ursa Major and Cygnus in their relationship with the seasonal path of the sun. It seems valid to assign them a function as sky charts, and perhaps as actual instruments for making astronomical observations.

Before concluding the analysis, and having dared to go to the lengths I have in suggesting a body of astronomical knowledge and its application by the Olmecs, I ought perhaps, to call attention to the recently published contour map of the La Venta pyramid. It can be seen (Figs, 2 and 3) that there is a systematic pattern of lobes and ridges which emanate from the apex. Although some erosion has obviously occurred, there is no appreciable depositional delta or fan at the bottom of the valleys. It therefore seems a fairly safe assumption that the shape of the cone has not drastically altered from its original form, and that its ridges and valleys were part of the original design. As has been explained, there is reason to believe that the main north-south axis of the La Venta site complex was oriented ca. 1000 B.C. to CP Ursae Majoris which set on the horizon 8° west of north. It seems to be, therefore, more than coincidence that the small mound at the northwest "corner" of the pyramid, between the 120° and 130° line on the map (V3 on Fig. 3), is located precisely at the setting azimuth of Gamma Cygni which was 126° at La Venta (Gamma Cygni: $\delta = +33.98$ at 1000 B.C.; see Azimuth

Chart p. 39). Since Gamma Cygni was a star of remarkably stable declination, it would have maintained an unchanging rising and setting azimuth as viewed anywhere in the northern hemisphere during the three millennia prior to 500 B.C. Although the mound at the opposite "corner" northeast of the pyramid does not lie at 126° but approximately at the 147° line instead (V9 on Fig. 3), it does not necessarily weaken the argument. If the objective of astronomical sightings were a year count, it would only have been required to count the elapsed number of days from the setting of a star at one day and hour of the year to the following year at the same time. That is to say, it would not have been necessary to observe both the rising and setting times of a particular star. The attention of La Ventans seems to have been mainly directed to the setting points and this may have included the setting sun as well. Above and beyond this, it makes a logical scheme that here are two definite points of alignment from the pyramid which are oriented to the setting azimuths of the centerpoints of two constellations which were analogous in many ways, as has already been discussed.

It may also be significant that the rising azimuth of the Pleiades in 1000 B.C. (Eta Tauri: $\delta = +10^\circ.77$) would have been approximately at 101°. This location is just about 90° from the main north-south axis of alignment and it can be seen that there is a deep channel at the 100° east line (V8 in Fig. 3). It has already been seen that the Pleiades rose as Cygnus crossed the meridian, a coincidence which we believe was inscribed on the Humboldt Celt. Opposite this line, at 80° west, (and at right angles to the main north-south axis), there is another deep channel (V4 in Fig. 3). In 1000 B.C., Delta Scorpii ($\delta = -9^\circ.79$) would have set at an azimuth of 80° at the same time that Eta Tauri was rising (the right ascensions of the two stars being different by 183°). A distinct channel also appears at 70° east (V7 in Fig. 3), and it is worth noting that the rising azimuth of Sirius ($\delta = -17^\circ.18$) was 72° at the time in question. Sirius is the brightest star in the sky, and would have risen about the time that Cygnus was setting.

The ridges and valleys of the La Venta pyramid and their possible function as sighting angles is a subject which is presented very tenuously; more study is necessary to make firm statements. Obviously, to show that one of the small mounds at the outer pyramidal edge was lined to the setting azimuth of a particular star implies the need to explain the functions of others that also are built around it. Furthermore, the factor of some erosional alteration of the pyramid's surface may weaken any sort of analysis about the precise function of the ridges and valleys of the pyramid. However, since there is presumably more than chance in the fact that five of the deepest channels are in direct line with the rising or setting azimuths of important stars and constellations, it seems worth mentioning. It may be significant that these channels we have determined as having been oriented to the setting azimuths of certain stars or constellations (CP Ursae Majoris, Gamma Cygni, Delta Scorpii) are stars whose declinations were increasing, and therefore were "falling" or appearing progressively lower in the sky. Those valleys oriented to the rising azimuths of stars (Eta Tauri, Sirius) were stars whose declinations were decreasing, and would have appeared to be "rising" in the sky.

The archaeological evidence (Berger, Graham, and Heizer 1967) suggests that the site of La Venta was abandoned about 600 B.C. The reason for the abandonment of the site will probably never be known and a dozen possibilities could be offered. Perhaps significant in view of the hypothesis presented in this paper, is the circumstance that by 500 B.C. the setting azimuth of CP Ursae Majoris would have been two degrees away from the alignment of the site, and the center of the Big Dipper was now setting at an azimuth of 10° west of north. Ursa Major was almost completely below the horizon as it crossed the meridian at its lower transit. Gamma Cygni would have culminated almost an hour after midnight; it would have made this transit 40 minutes before Alpha Ursae Majoris reached the meridian, so there would have been little relationship between the two meridian crossings of these constellations. The whole pattern, as celebrated in Olmec iconography and relating the constellations and stars with the solar and sidereal years was, by 500 B.C., seriously out of step with apparent events. Although hardly sufficient cause for the total abandonment of a site, it seems possible that these factors may have had some influence.

The Mesoamerican cosmological myth holds that the jaguar sun was deposed from his supreme role in the night sky, and there are some grounds for believing the occurrence may have had a factual basis, and that a conceptual change did occur. Certainly by the time the next great civilization becomes apparent in Mesoamerica, that of the Maya, the cultural emphasis is on a celestial serpent rather than the jaguar, alghough the latter is still recognized. What the relationship is between Maya and Olmec cultures is not yet clear but there are hints that the Olmecs and the Maya were sharing some knowledge of calendrical glyphs and numeration as early as the first century B.C. At what earlier time these two peoples may have been in contact and exchanged such knowledge we do not know, but that time could have been as long ago as the early centuries of the first millennium B.C. An interesting artifact in this respect is the cylinder seal from Tlatilco (Fig. 27) portraying three separate glyphs. On the left is the familiar profile we have analyzed as the Ursa Major-related jaguar deity. At the center is the cleft design containing the M-Element above the four units divided by a center line. According to our analysis, the two glyphs relate to the setting of CP Ursae Majoris into the horizon as it crosses the meridian. It seems possible that the third glyph, on the right, is a symbol for the sun, since it resembles very much the Maya kin sign meaning "sun." Here again the subject matter (in this case employed only as a design without implication of utilitarian function) appears to relate to the night and day skies, the sidereal and solar years, and the relationship of the position of Ursa Major with respect to the meridian at the various seasons. It is intriguing that on this seal the typically Olmec designs are shown in the same context with what later appears as a Maya glyph. We are of the opinion that the Olmecs used glyphs, and base this on the evidence of the inscription on the Humboldt Celt and other inscribed pieces such as the celt shown here in Fig. 38 which was excavated in 1955 at La Venta (Drucker, Heizer, and Squier 1959:140-141) in Offering No. 2 assignable to Phase III and dating from some time, perhaps a couple of centuries, earlier than 600 B.C. (Berger, Graham, and Heizer 1967). The engraved celts excavated in 1955 at La Venta are particularly important pieces because they stand alone among the much larger corpus of Olmec-attributed finely-engraved art in being unquestionably part of Olmec culture, something we cannot prove, unfortunately, for the Humboldt Celt.

With respect to the symbol for nought or completion, it is possible that the year count was considered to be completed at the time of the summer solstice; we have argued that the presentation of the infant in Olmec art is associated with the new year beginning June 21. The superimposition of the Cygnus crossed bands on the Kan cross (as shown on Fig. 38) may have become a symbol to convey the meaning for "completion." In Maya epigraphy, crossed diagonal lines superimposed on a four-petaled motif is suggested as a design related to what is known as a completion symbol (Thompson 1950:fig. 44, 1, 2; 45, 3). Although we are not arguing that the Maya symbol is the same as that found in Olmec art, it could be that the basic concepts of the two symbols are related.

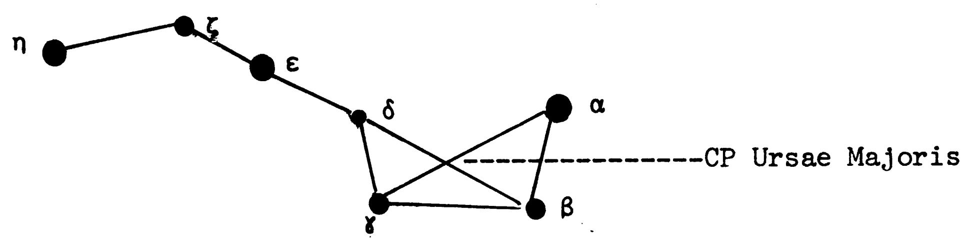
This paper has set forth an hypothesis proposing an astronomical basis for the alignment of the La Venta site. The argument seems to be supported by certain elements of Olmec iconography. Few unequivocal interpretations are possible at this time regarding Olmec glyphs, but the consistency and obvious patterning of many of these (especially certain series inscribed on celts and held here to be "star maps") appear to make them more than simple decorative expressions. Put another way, it is hardly probable that embellishment of the sort found on the Humboldt Celt and the La Venta Offering No. 2 Celt (Fig. 38) could be purely decorative or artistic and at the same time be amenable to a consistent and reasonably complete reading in terms of astronomical symbolism.

There are many areas of the subject yet to be explored, and there are details presented here which will have to be modified as more information is supplied. Yet we believe we have established two features of the La Venta period Olmec culture. The first is that they possessed an organized practical astronomy whose central function was calendrical. The second is that a certain portion of Olmec symbolism can be interpreted as glyphic records of astronomical phenomena such as meridian transits in connection with solstices.

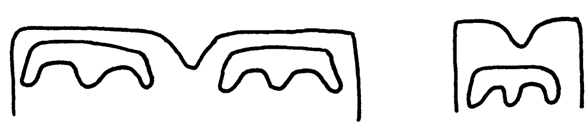
Notes

1. For the reader's convenience, certain abbreviations used in this paper are listed here for easy reference:

> χ: right ascension. A co-ordinate in the equator system measured from the vernal equinox eastward to the point where the hour circle of a star intersects the celestial equator.
>
> δ: declination. The co-ordinate in the equator system which is the measure of the angular distance of a body from the celestial equator.
>
> CP Ursae Majoris. Centerpoint of the "bowl" of the "Dipper" of Ursae Majoris, determined by the point of intersection of the Alpha-Gamma and Beta-Delta diagonal lines of that constellation.



> M-Element: A design that usually looks like an "M" on either side of a cleft or central axis. Alternatively the whole unit itself will compose the "M" with a central axis dividing it.



2. Drucker, Heizer and Squier (1959:15) earlier wrote: "Whatever the specific reason which impelled the builders of La Venta to orient the centerline along 8° west of true north, we feel that it is significant that the majority of Mesoamerican sites are built on north-south alignments, and from this conclude that the La Venta Olmec were early participants in this widespread practice. This whole problem is one in urgent need of exploration".

3. I wish to thank Dr. Alexander Pogo of the Carnegie Institution of Washington for his kind and generous assistance on the astronomical parts

of this paper, since this aid has been of major importance in enabling the present analysis to be realized. Professors John A. Graham and Robert F. Heizer at Berkeley have been kind enough to help me with reference materials and to read this report. My graduate student colleagues, Thomas R. Hester who has made the drawings, and C. William Clewlow, Jr. who has helped me locate some of the illustrations also have my thanks for their assistance.

4. Astronomical data of the diagrams and azimuth table, as well as values for right ascensions and declinations of stars during the millennia before the present are taken from Paul Victor Neugebauer's Tafeln zur Astronomischen Chronologie, vols. I-III, Leipzig 1912-1925.

5. We first examined the idea that the site complex at La Venta may have been oriented to Alpha Draconis by tradition of its having been the ancient Polestar, but calculations showed this idea to be untenable. The radiocarbon evidence from the La Venta site places the age of Phase I at approximately 1000 B.C. (Berger, Graham, and Heizer 1967), at which time Alpha Draconis was about 10° from the pole, a deviation dignificantly greater than the orientation of the site centerline. Further investigation led to the conclusion that the site was aligned to the constellation Ursa Major (the Big Dipper).

6. Planting time seems to have been weather-determined rather than strictly calendrical, according to the estimated onset of the first rains. Standard planting dates in Mesoamerica vary from April 11th (Long 1948:216), to the end of May just following the first rains (Morley 1956:134), to the first two weeks of June (Heizer, personal communication). This is because the rain pattern is different in the various parts of the lowlands. Differences in terrain may also affect the time of planting.

7. Faces do not seem to be shown facing south. The "south" position (lower transit) of the Dipper is usually shown by the M-Element, indicating that it sets into the horizon. Possibly, the profile is not shown at that position because it is not visible at that time in its circumpolar journey.

8. There may be additional astronomy-related features in these large filled pits. One could suggest here the possibility of a lunar count recorded in the 28 layers of serpentine which underly the mosaic masks (Drucker, Heizer and Squier 1959:102).

AZIMUTHS for ϕ = 18°

δ	W_3+W_1	δ	W_3+W_1	δ	W_3-W_1	δ	W_3-W_1
+72°	180°						
71	175.6						
+70°	172°.4	+30°	121°.8	-1°	89°.1	-41°	46°.7
69	170.0	29	120.8	2	88.1	42	45.6
68	168.0	28	119.8	3	87.0	43	44.5
67	166.2	27	118.7	4	86.0	44	43.4
66	164.5	26	117.6	5	85.0	45	42.4
+65°	163.0	+25°	116.5	-6°	83.9	46°	41.3
64	161.5	24	115.4	7	82.8	47	40.2
63	160.1	23	114.4	8	81.8	48	39.0
62	158.7	22	113.3	9	80.7	49	37.8
61	157.4	21	112.2	10	79.7	50	36.6
+60°	156.1	+20°	111.2	-11°	78.7	-51°	35.5
59	154.7	19	110.2	12	77.6	52	34.4
58	153.5	18	109.1	13	76.6	53	33.3
57	152.3	17	108.1	14	75.5	54	32.1
56	151.1	16	107.1	15	74.4	55	30.9
+55°	149.9	+15°	106.0	-16°	73.3	-56°	29.7
54	148.7	14	104.9	17	72.3	57	28.5
53	147.5	13	103.8	18	71.3	58	27.3
52	146.2	12	102.8	19	70.2	59	26.1
51	145.1	11	101.7	20	69.2	60	24.9
+50°	144.0	+10°	100.7	-21°	68.2	-61°	23.6
49	142.8	9	99.7	22	67.1	62	22.3
48	141.6	8	98.6	23	66.0	63	21.1
47	140.4	7	97.4	24	65.0	64	19.7
46	139.3	6	96.5	25	63.9	65	18.2
+45°	138.2	+5°	95.4	-26°	62.8	-66°	16.9
44	137.2	4	94.4	27	61.7	67	15.4
43	136.1	3	93.4	28	60.6	68	13.8
42	135.0	2	92.3	29	59.6	69	12.0
41	133.9	1	91.3	30	58.6	70	10.2
+40°	132.8	0°	90°.2	-31°	57.5	-71°	8.0
39	131.7			32	56.4	-72	0°
38	130.5			33	55.4		
37	129.4			34	54.3		
36	128.3			35	53.2		
+35°	127.2			-36°	52.1		
34	126.1			37	51.2		
33	125.0			38	50.1		
32	124.0			39	48.9		
31	122.9			40	47.8		

For stars rising: azimuths counted from S over East to N

For stars setting: azimuths counted from S over West to N

Addenda to Table 16 (P. 46) and to Table 18 (p. 48) in vol. III of P.V. Neugebauer's TAFELN ZUR ASTRONOMISCHEN CHRONOLOGIE Leipzig 1925

Values of W_1 for $\phi = 18°$

δ	W_1	δ	W_1	δ	W_1	δ	W_1
0°	0°						
1	1.1	21°	22°0	41°	43°6	61°	66°9
2	2.1	22	23.1	42	44.7	62	68.2
3	3.2	23	24.2	43	45.8	63	69.5
4	4.2	24	25.2	44	46.9	64	70.9
5	5.2	25	26.3	45	47.9	65	72.4
6	6.3	26	27.4	46	49.0	66	73.8
7	7.4	27	28.5	47	50.1	67	75.4
8	8.4	28	29.6	48	51.3	68	77.1
9	9.5	29	30.6	49	52.5	69	79.0
10	10.5	30	31.6	50	53.7	70	81.1
11	11.5	31	32.7	51	54.8	71	83.8
12	12.6	32	33.8	52	55.9		
13	13.6	33	34.8	53	57.1		
14	14.7	34	35.9	54	58.3		
15	15.8	35	37.0	55	59.5		
16	16.9	36	38.1	56	60.7		
17	17.9	37	39.1	57	61.9		
18	18.9	38	40.2	58	63.1		
19	20.0	39	41.4	59	64.3		
20	21.0	40	42.5	60	65.6		

Values of W_3 for $\phi = 18°$

δ	W_3	δ	W_3
0° - 36°	90°2	66°	90°7
37 - 52	90.3	67	90.8
53 - 59	90.4	68	90.9
60 - 62	90.5	69	91.0
63 - 65	90.6	70	91.3
		71	91.8

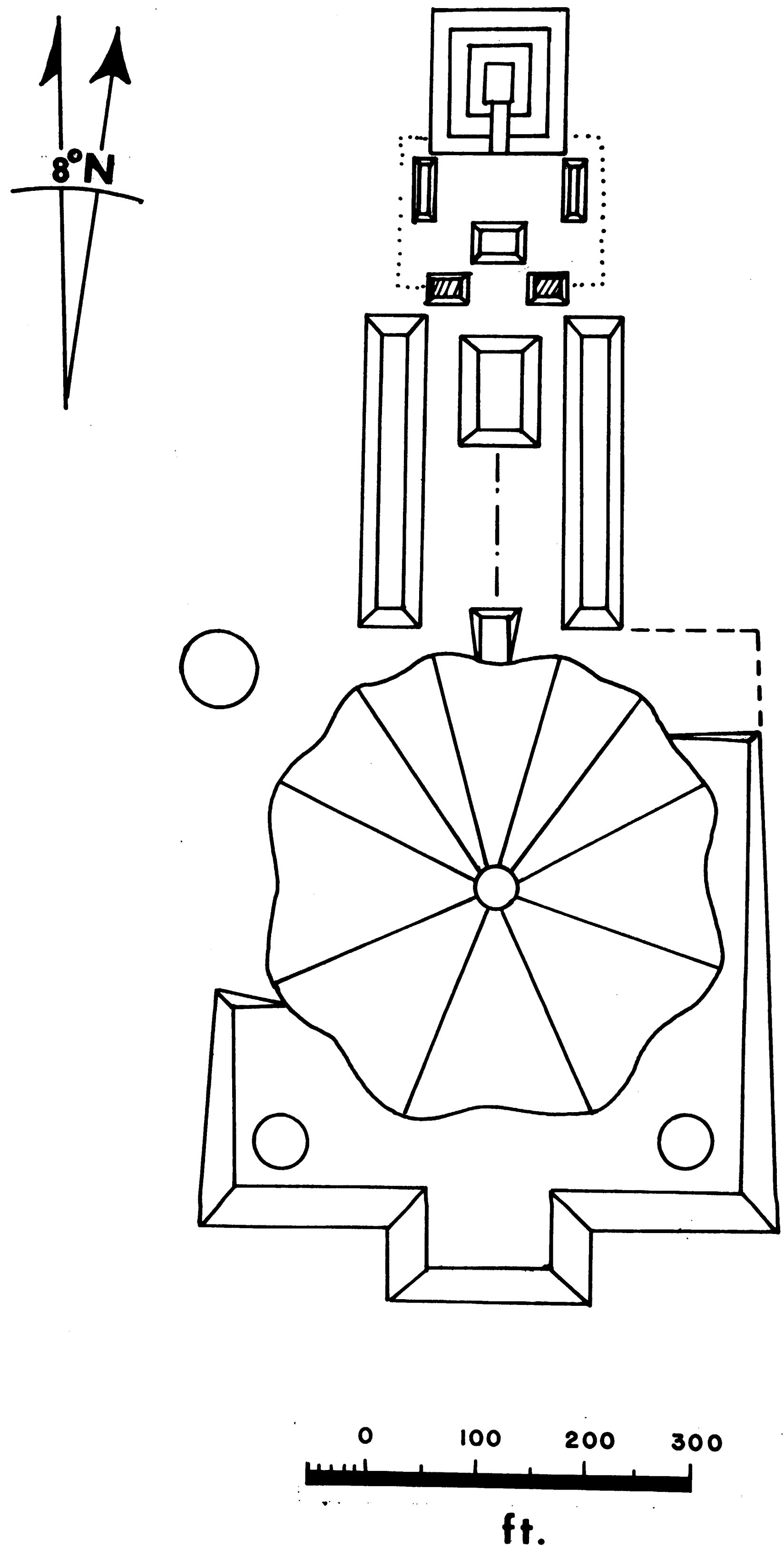


Fig. 1. La Venta, Tabasco, Mexico. Site plan. The two hachured rectangles show location of the two mosiac masks.

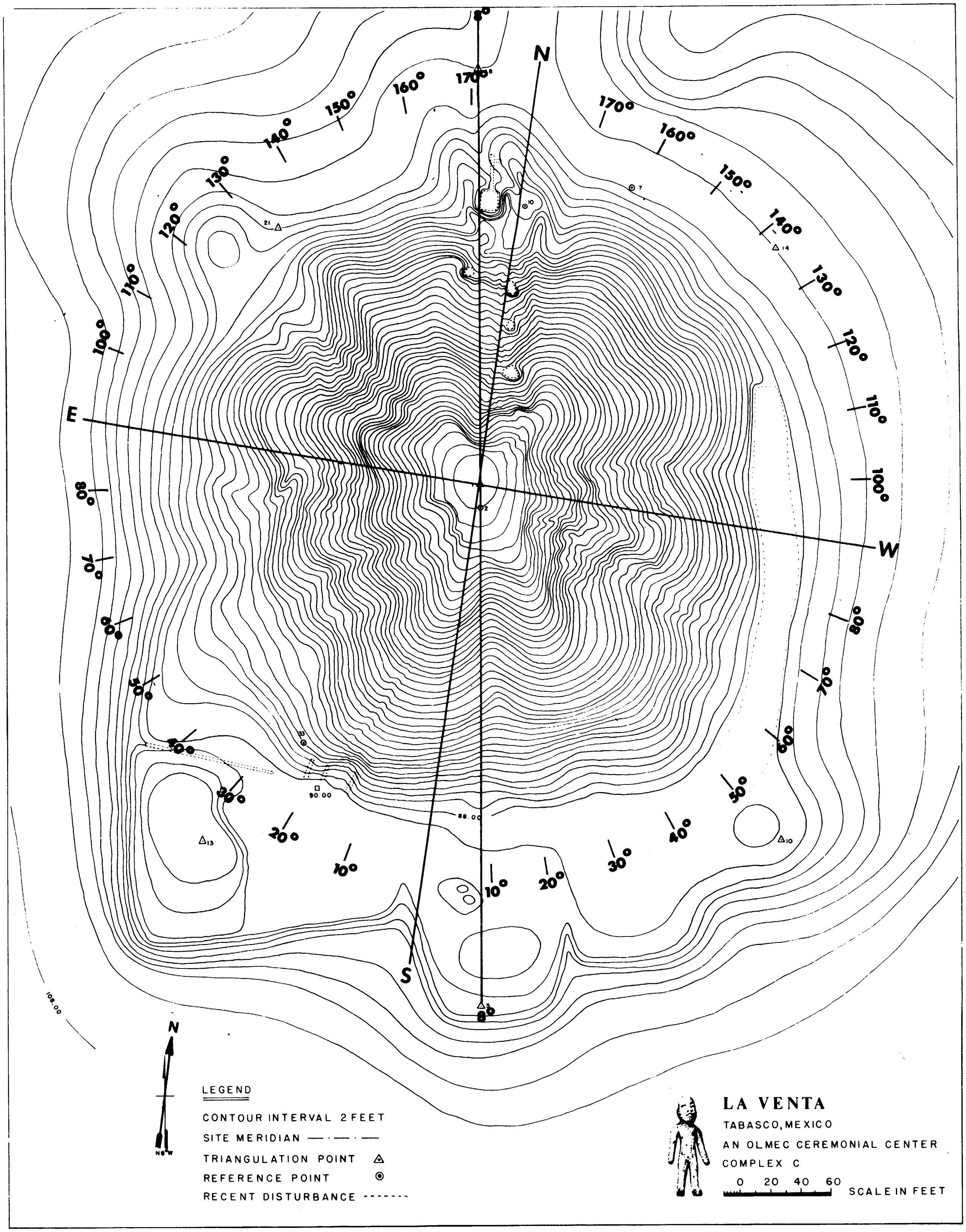


Fig. 2. Contour map of the Pyramid at La Venta Site.

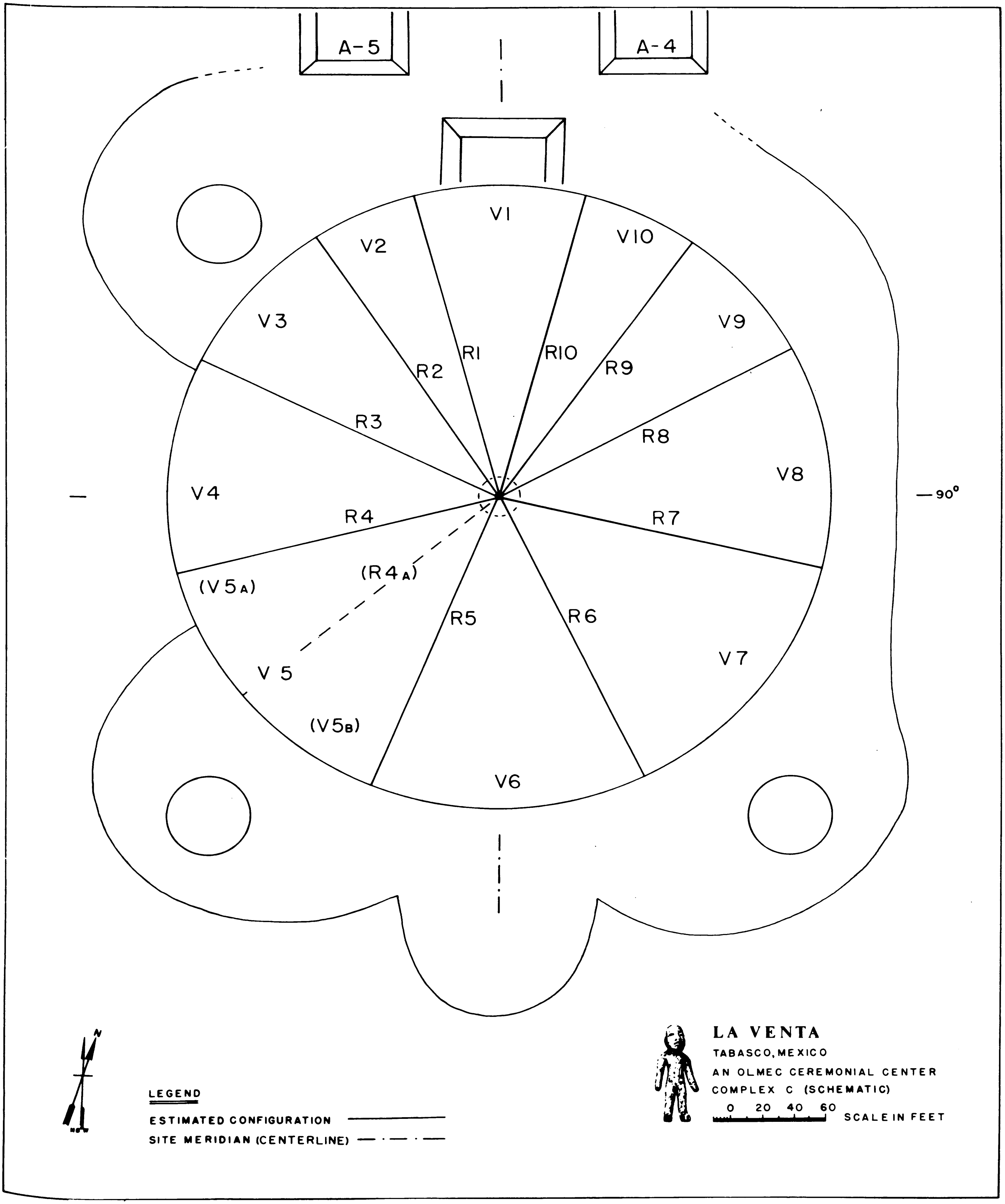


Fig. 3. Schematic representation of the ridges of the La Venta pyramid.

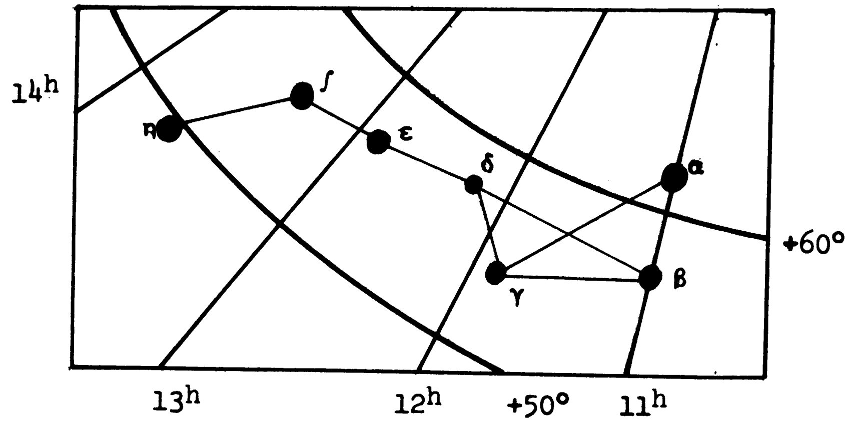


Fig. 4. The Big Dipper (Ursa Major)

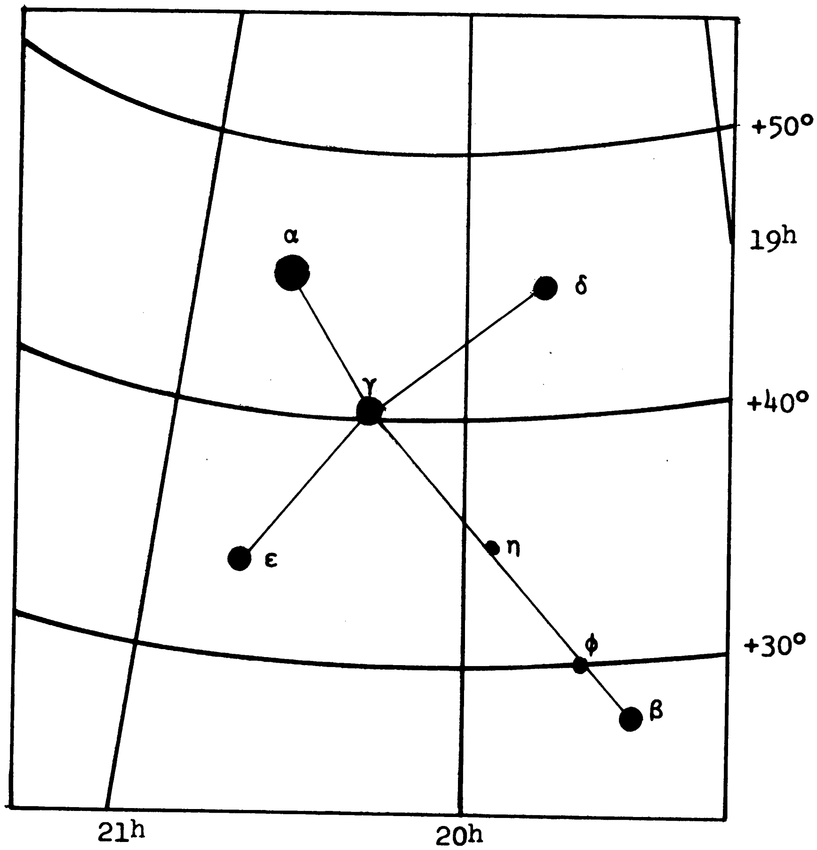


Fig. 5. Cygnus

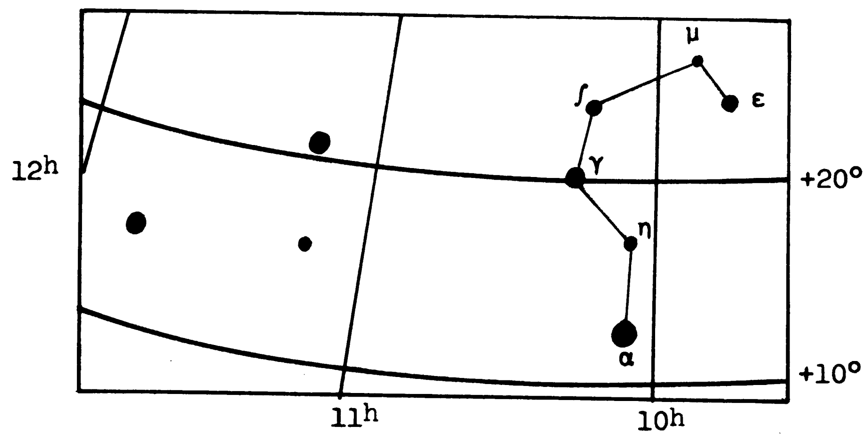


Fig. 6. The Constellation Leo

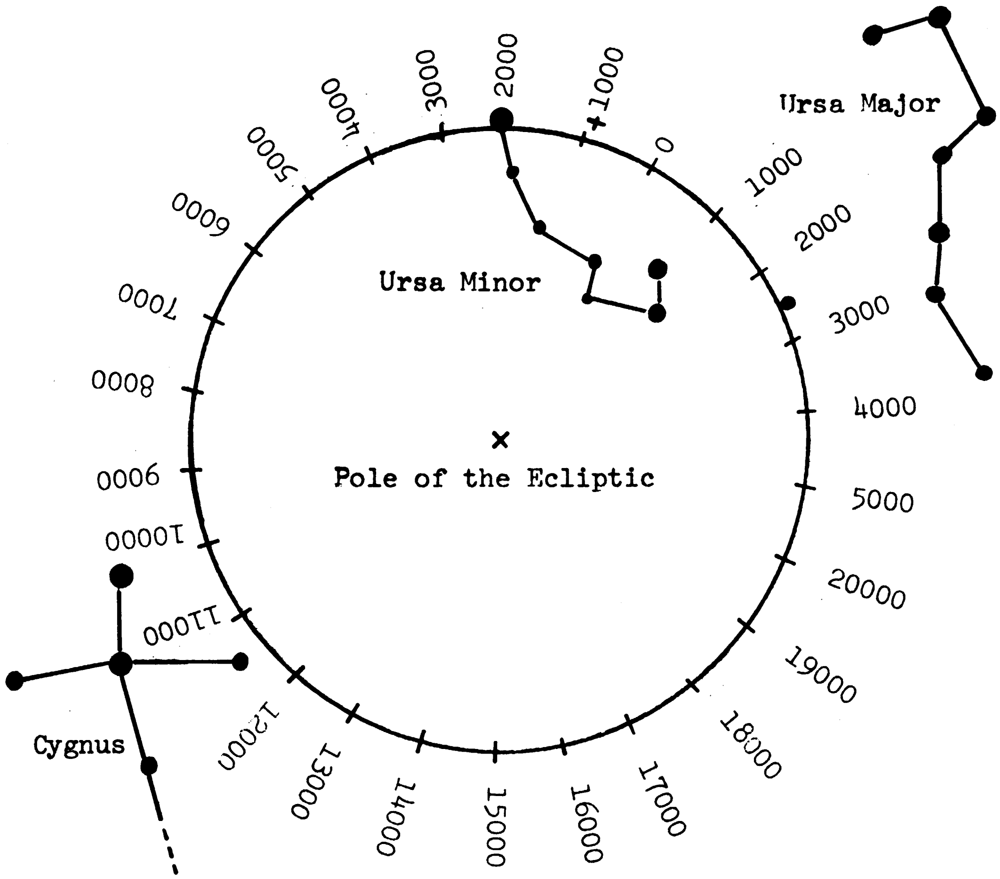


Fig. 7. Precessional path of the North celestial pole. The celestial pole describes a circle of 23 1/2° radius around the ecliptic pole.

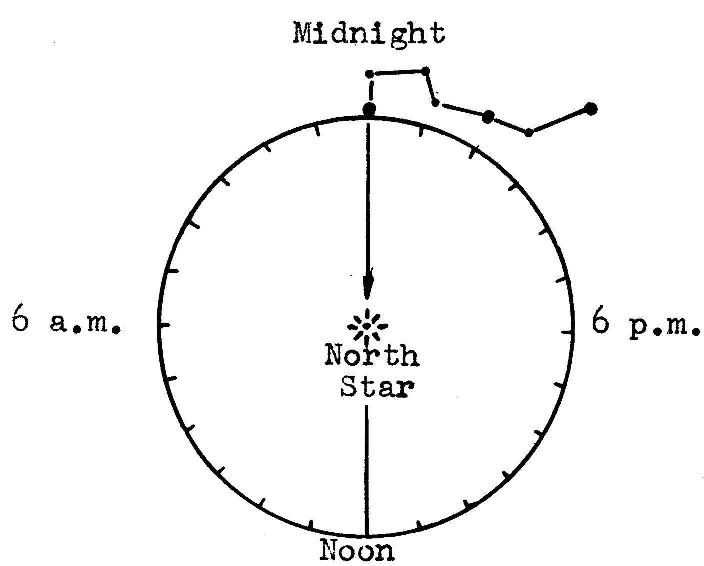


Fig. 8. Big Dipper clock for night of March 5. At midnight the pointers are directly above the North Star. They move west (left) 15 degrees each hour.

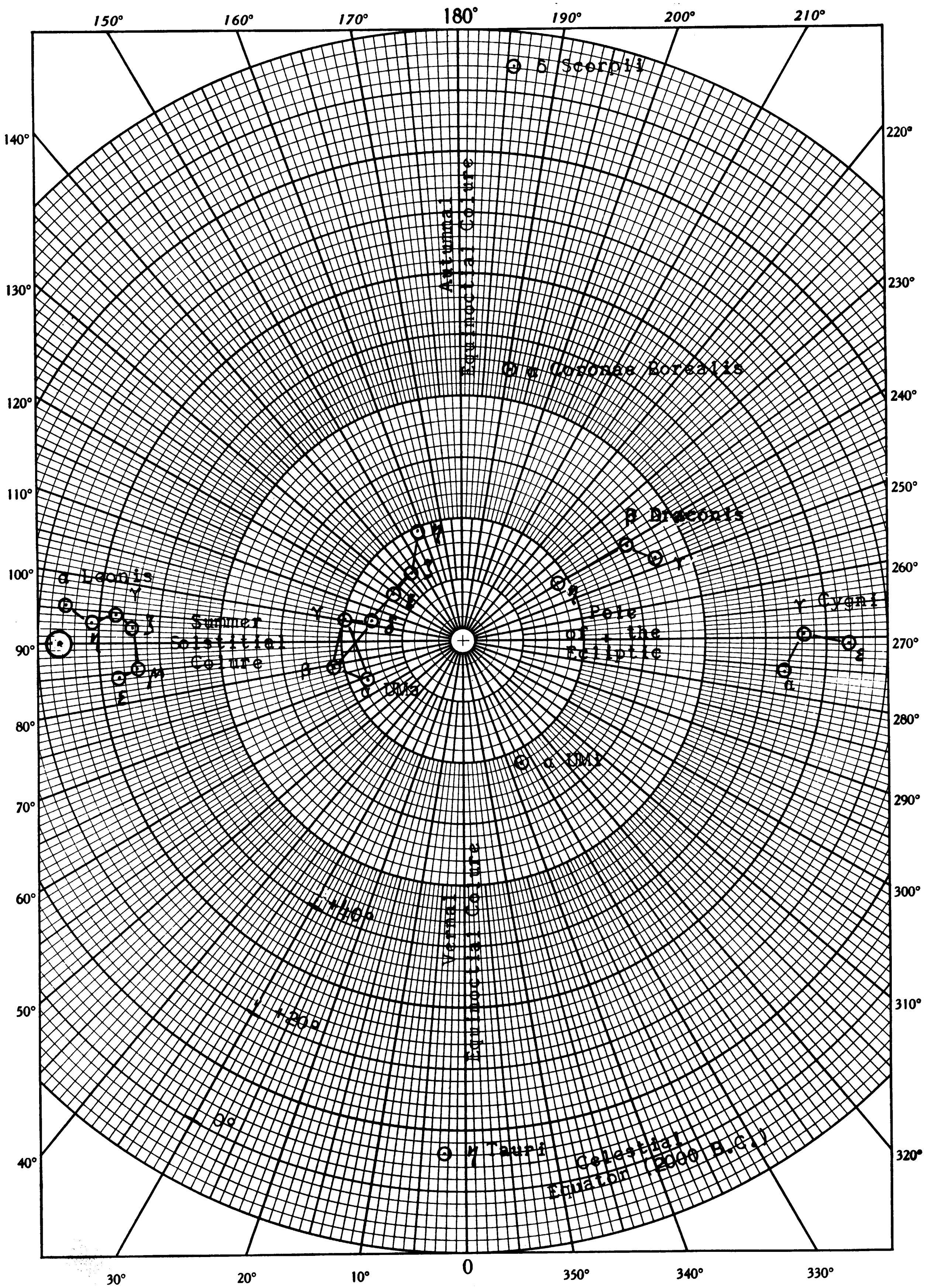


Fig. 9. Polar diagram of right ascensions and declinations, for 2000 B.C., of selected stars. Center of the diagram: North celestial pole.

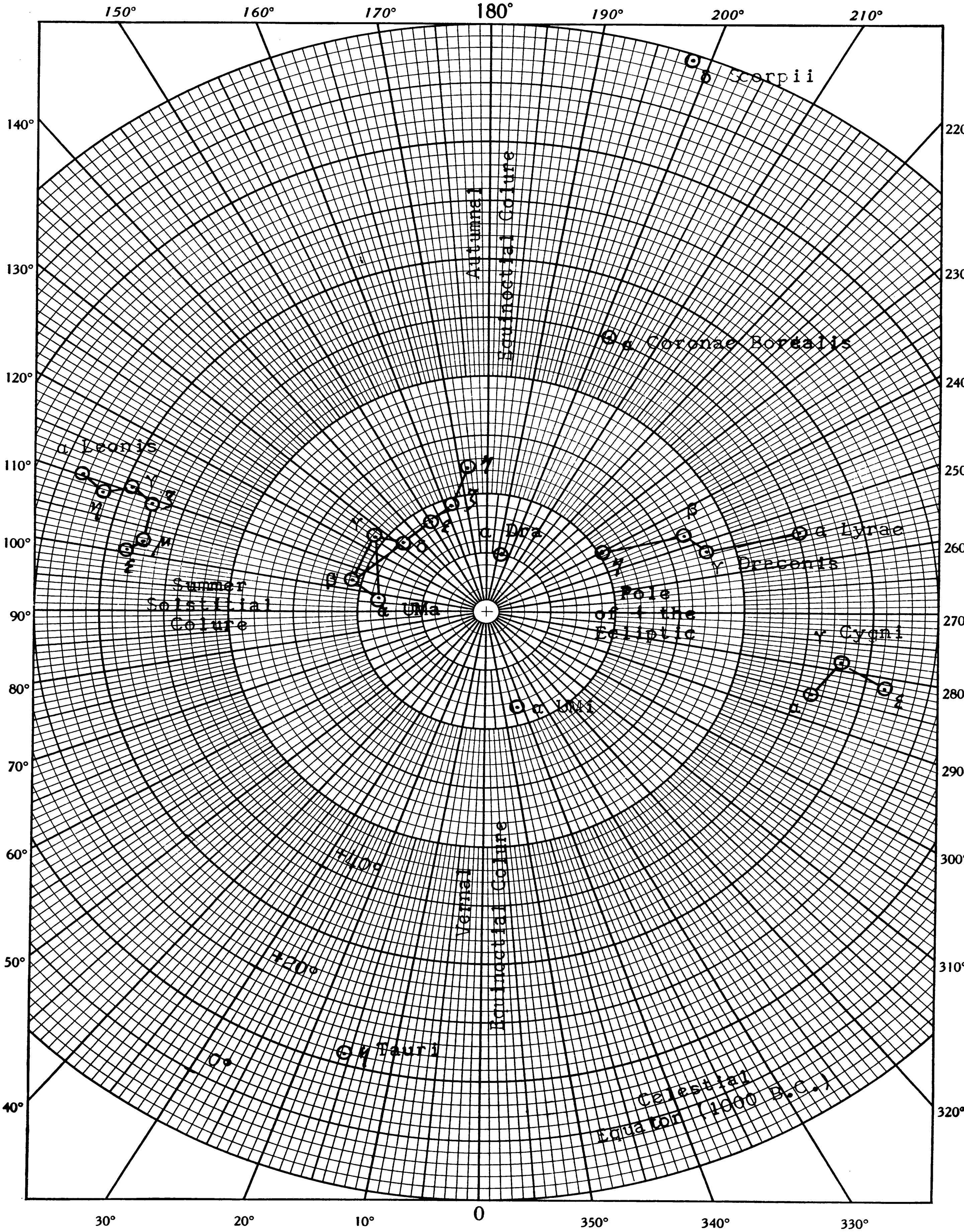


Fig. 10. Polar diagram of right ascensions and declinations, for 1000 B.C., of selected stars. Center of the diagram: North celestial pole.

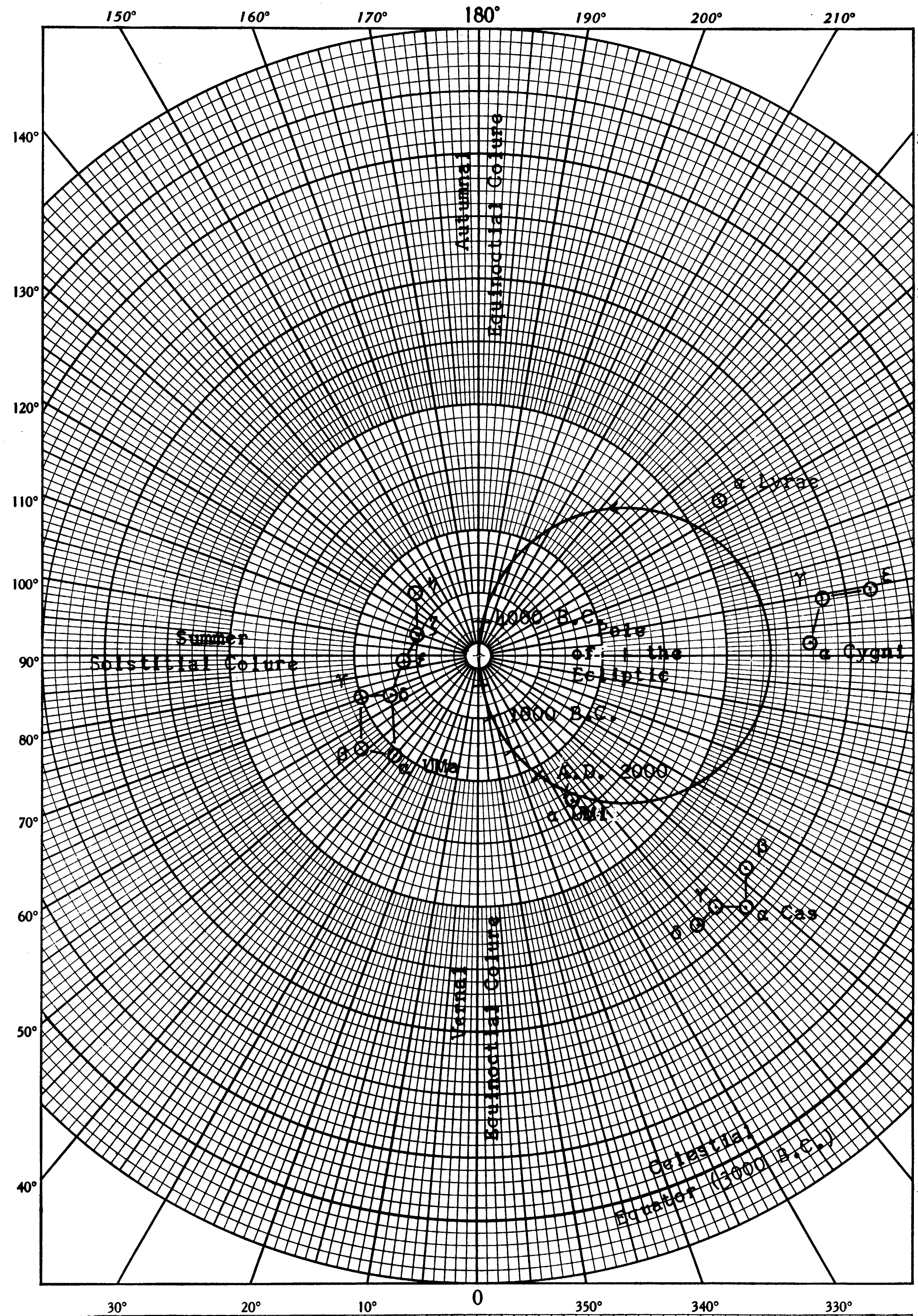


Fig. 11. Polar diagram of right ascensions and declinations, for 3000 B.C., of selected stars. The path of the North celestial pole around the North pole of the ecliptic is shown.

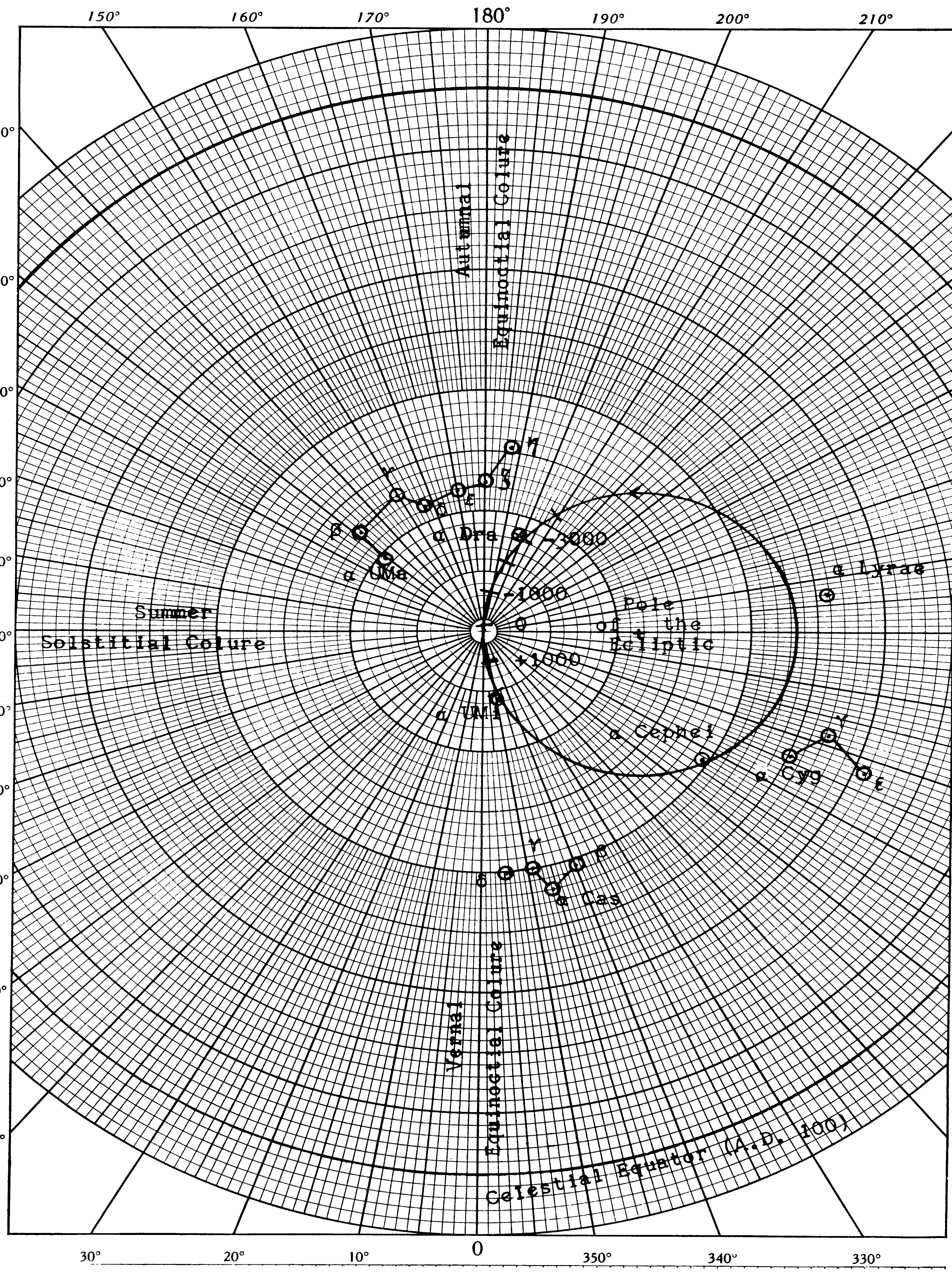


Fig. 12. Polar diagram of right ascensions and declinations, for A.D. 100, of selected stars. Center of the diagram: North celestial pole. The path of the North celestial pole around the North pole of the ecliptic is shown.

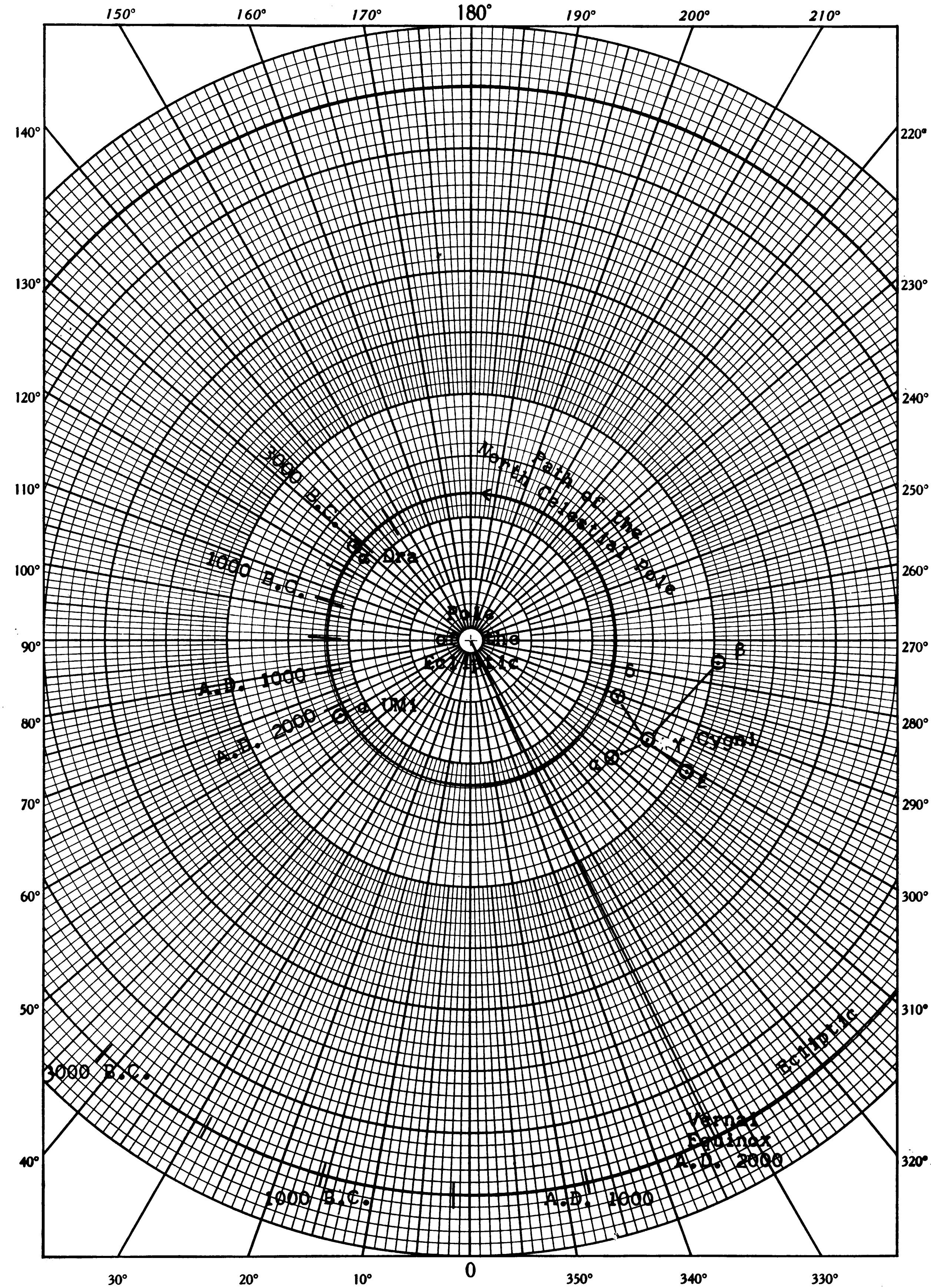


Fig. 13. Polar diagram of longitudes and latitudes, for A.D. 100, of selected stars. Center of the diagram: North pole of the ecliptic. The path of the North celestial pole around the North pole of the ecliptic is shown.

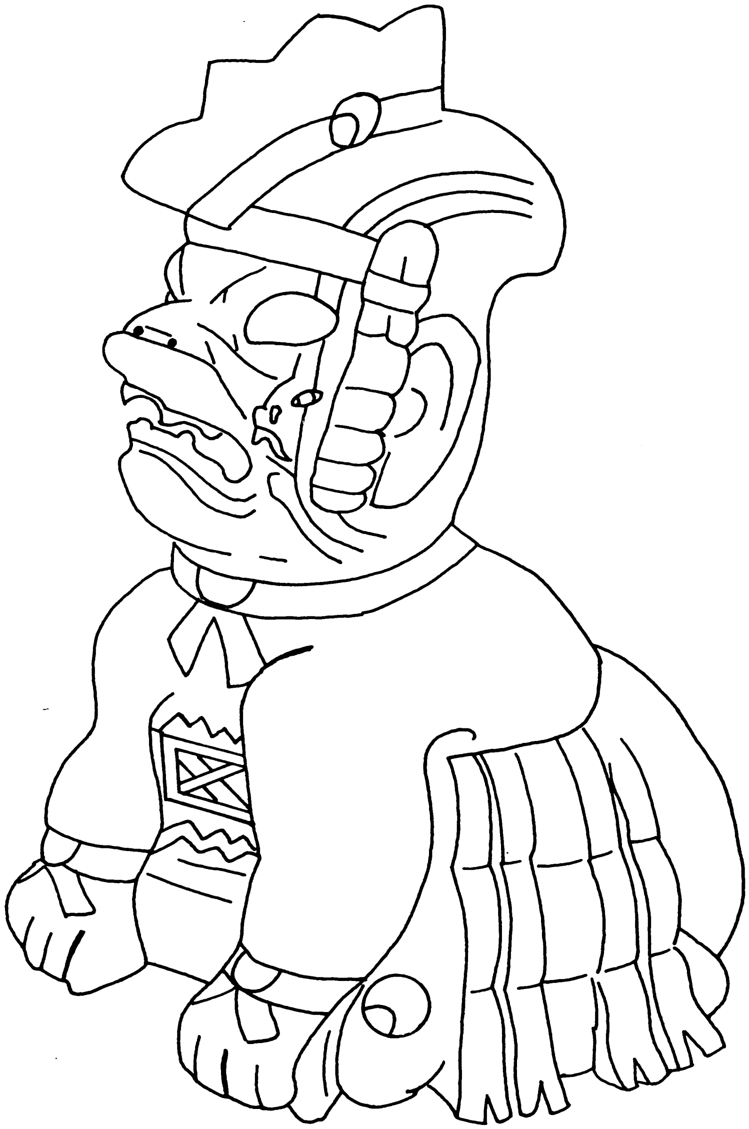


Fig. 14. Blue-green jadeite figure from Necaxa, Puebla, Mexico. (After Covarrubias 1957, facing p. 78, left).

Fig. 15. Monument 52 from San Lorenzo Tenochtitlan (After Easby and Scott 1970, No. 34).

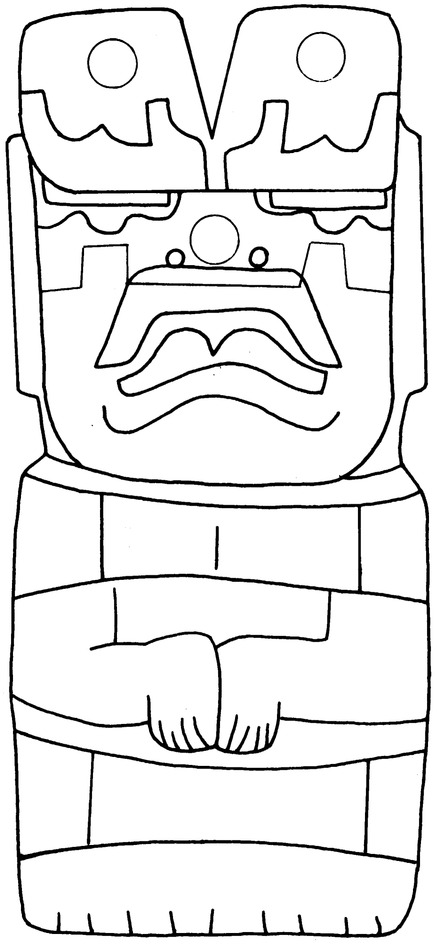


Fig. 16. Stone effigy axe, probably from Oaxaca. (After Coe, 1965, Fig. 28).

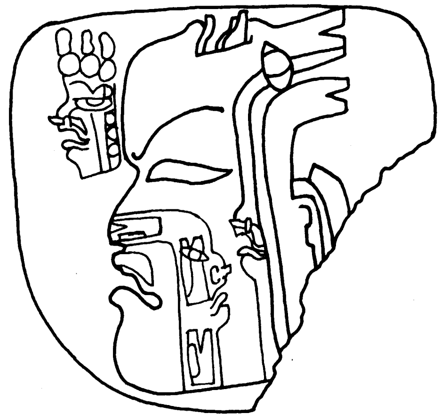


Fig. 17. Jade plaque, provenience unknown. (After Covarrubias, 1957, Fig. 35 top left).

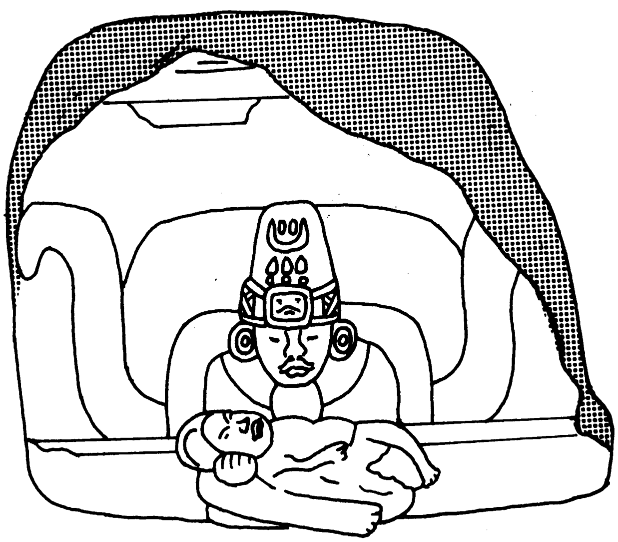


Fig. 19. La Venta Altar 5. (After Stirling 1965, Fig. 20, top)

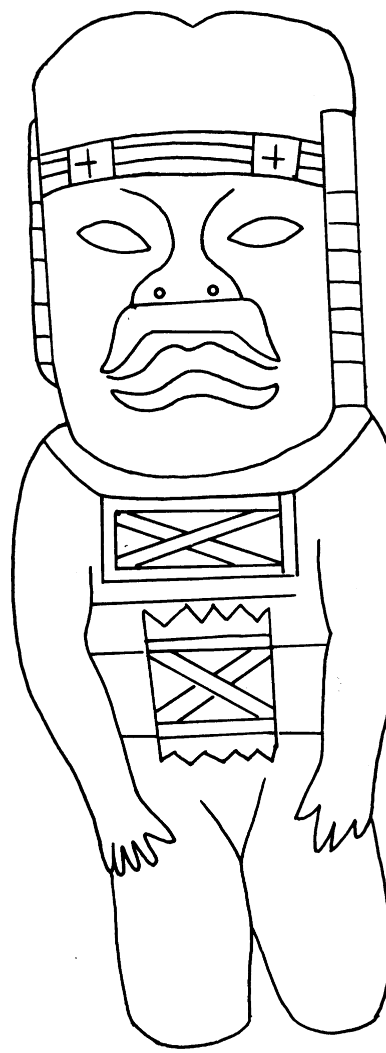


Fig. 20. Infant held in arms of Las Limas Figure shown in Fig. 40).

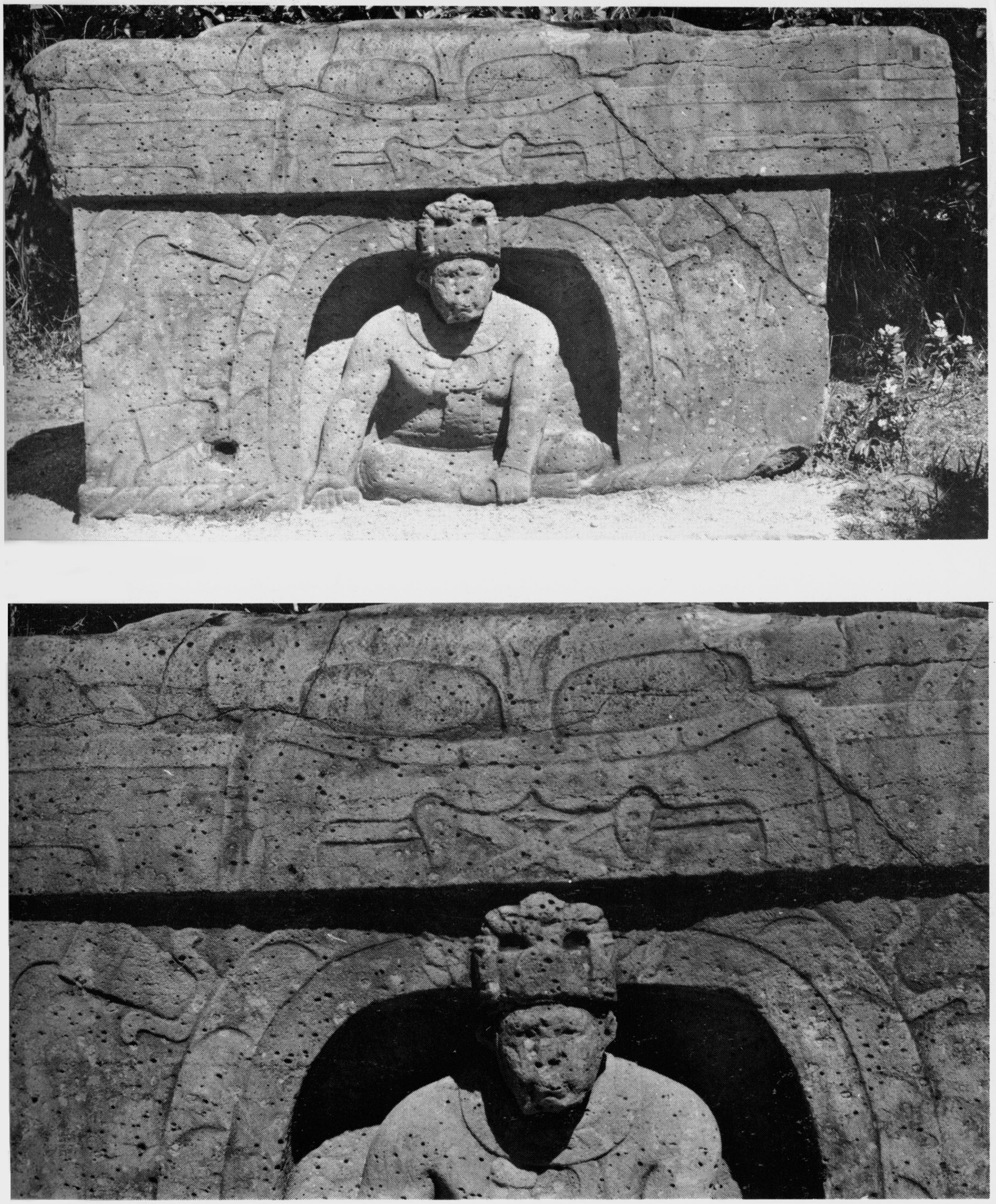


Fig. 18. La Venta Altar 4.

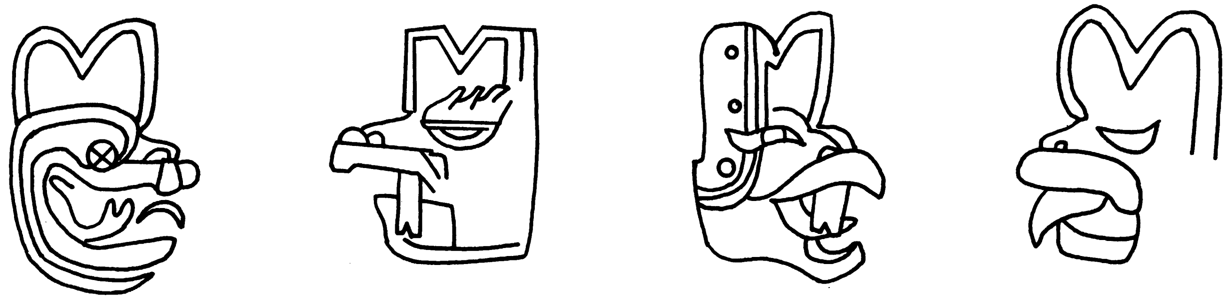


Fig. 21. Profile faces incised on shoulders and knees of Las Limas Figure.

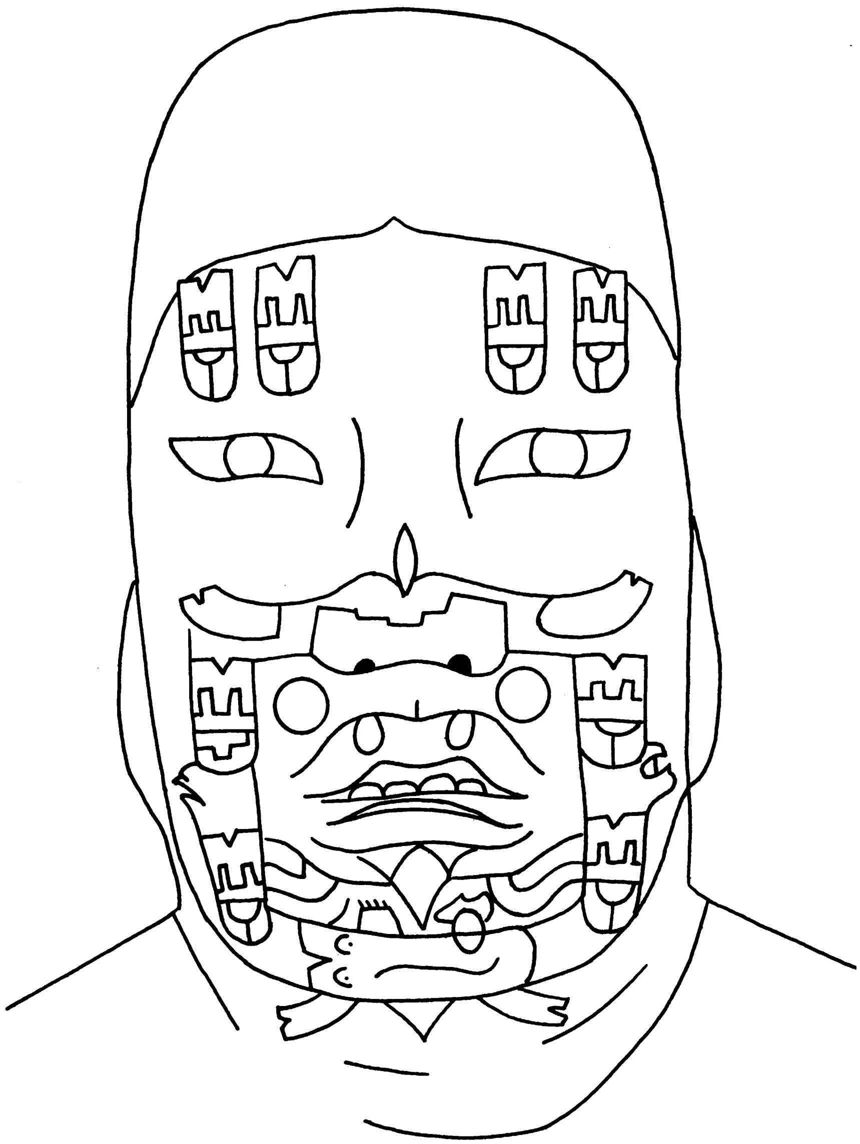


Fig. 22. Design incised on face of Las Limas Figure (see Fig. 40).

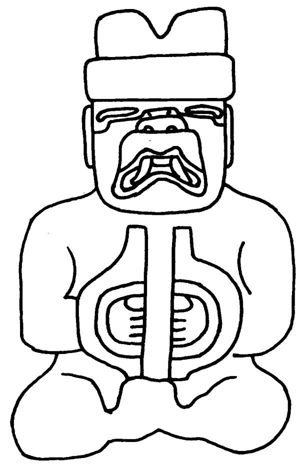


Fig. 23. Monument 10 from San Lorenzo Tenochtitlan. (After Covarrubias, 1957)

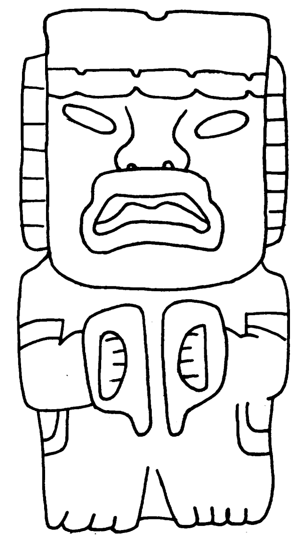


Fig. 24. Jade figurine from Pichualco, Chiapas, Mexico. (After Cervantes 1969, Fig. 14)

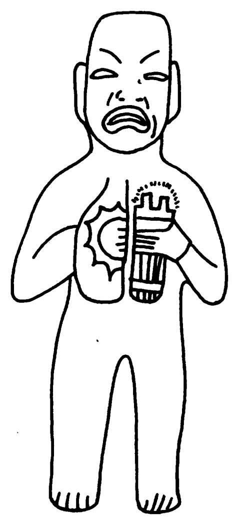


Fig. 25. Jade figurine from San Cristobal, Tepatlaxco, Puebla, Mexico. (After Coe 1965, Fig. 8).

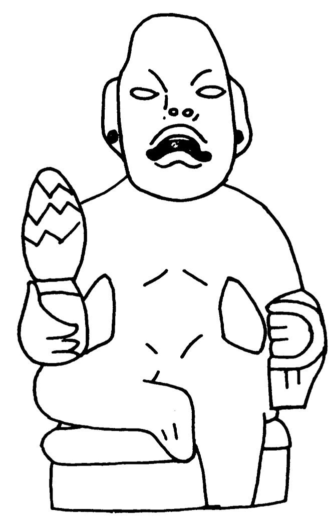


Fig. 26. Jade figurine, provenience unknown. (After Coe 1965, Fig. 12).

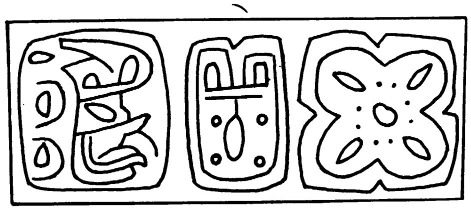


Fig. 27. Glyphs on a roller stamp found at Tlatilco, Mexico. (After Coe 1965, Fig. 47).

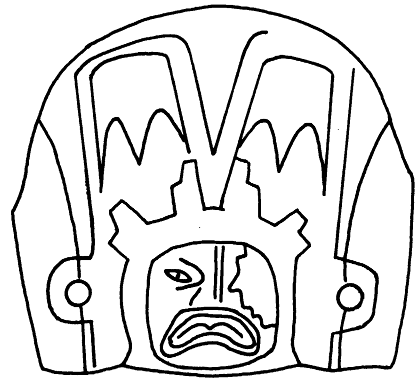


Fig. 28. Yuguito from Tlacotepec, Guerrero, Mexico. (After Coe 1965, Fig. 4).

Fig. 29. Engraved celt, provenience unknown. (After Coe 1965, Fig. 52).

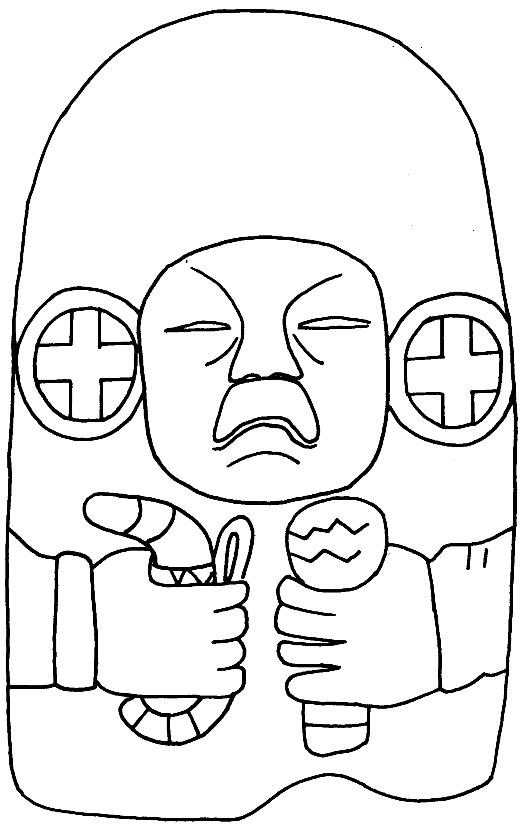


Fig. 30. Figure of deep green serpentine, provenience unknown. (After Easby and Scott 1970, No. 37).

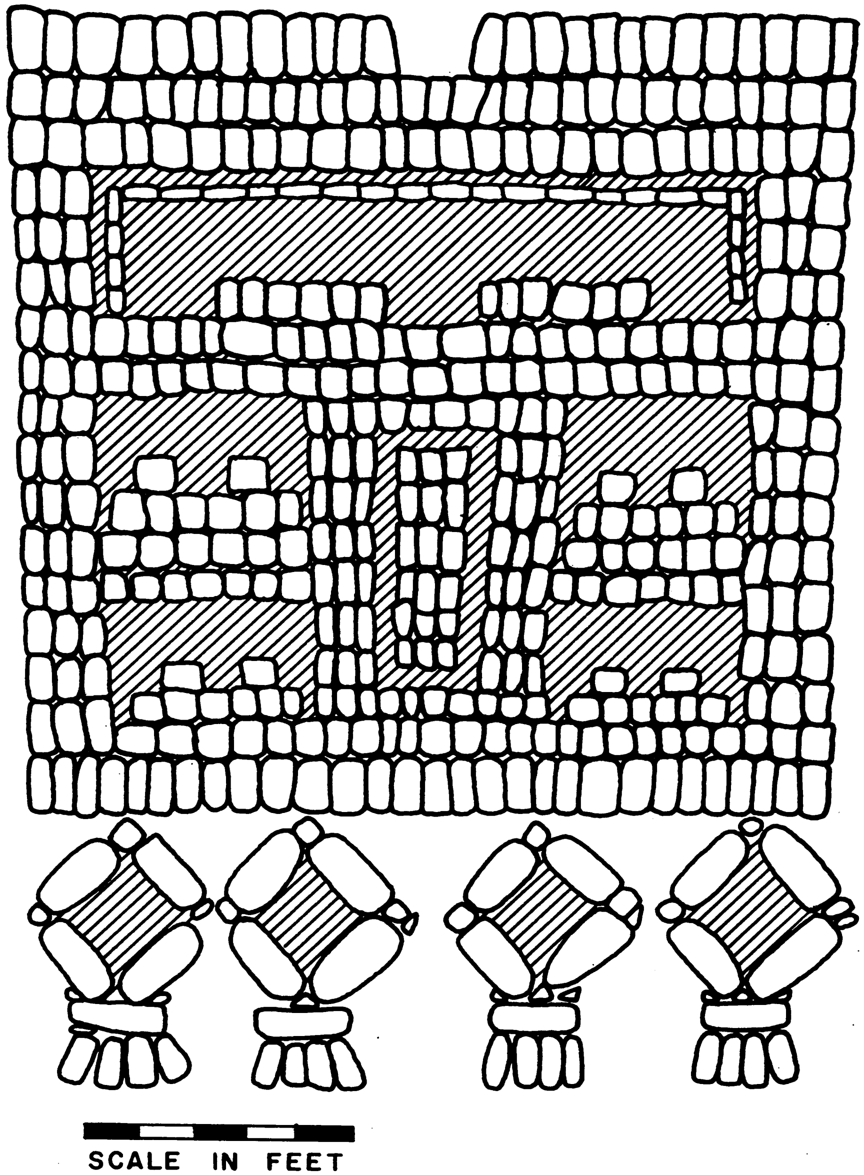


Fig. 31. Mosaic mask in Southwest Platform, La Venta site (After Drucker, Heizer and Squier, Fig. 28). Hachured areas are unfilled; open areas are stone blocks.

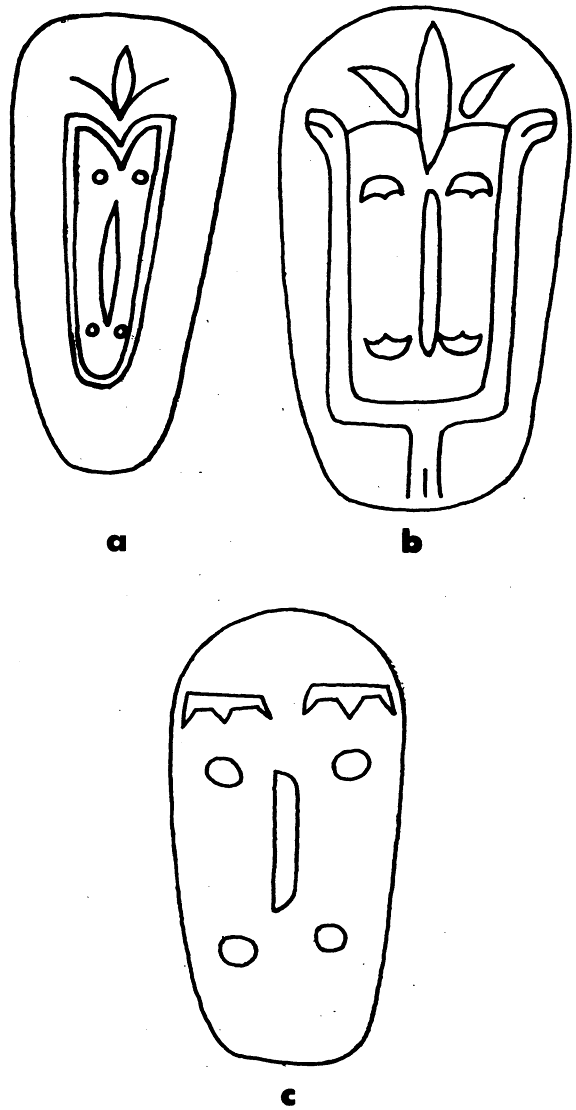


Fig. 33. Celts from La Venta site (a and b after Drucker 1952, Fig. 47; c after Drucker, Heizer and Squier 1955, Fig. 35c.)

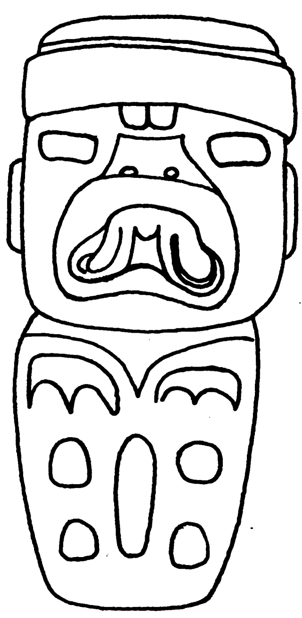


Fig. 32. "Votive axe," unknown provenience. (After Covarrubias 1957, Fig. 32, lower right).

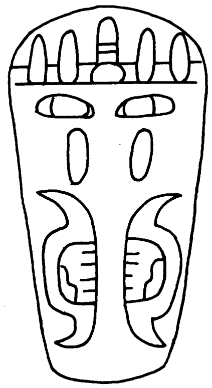


Fig. 34. Celt from La Venta. (After Covarrubias 1957, Fig. 34, center).

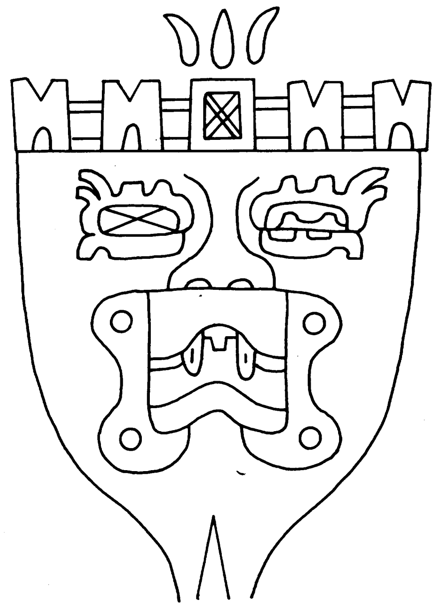


Fig. 35. Celt from Los Tuxtlas, Veracruz, Mexico. (After Piña Chan 1964, Fig. 1).

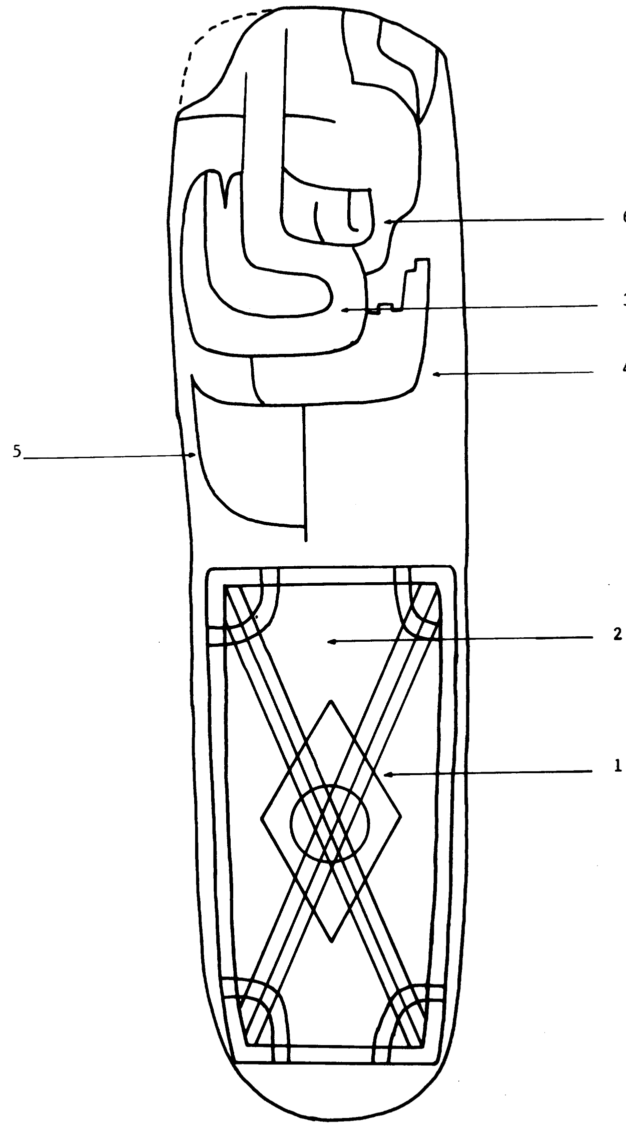


Fig. 38. Serpentine celt from Offering No. 2, La Venta. (From Drucker, Heizer and Squier 1955, Pl. 24).

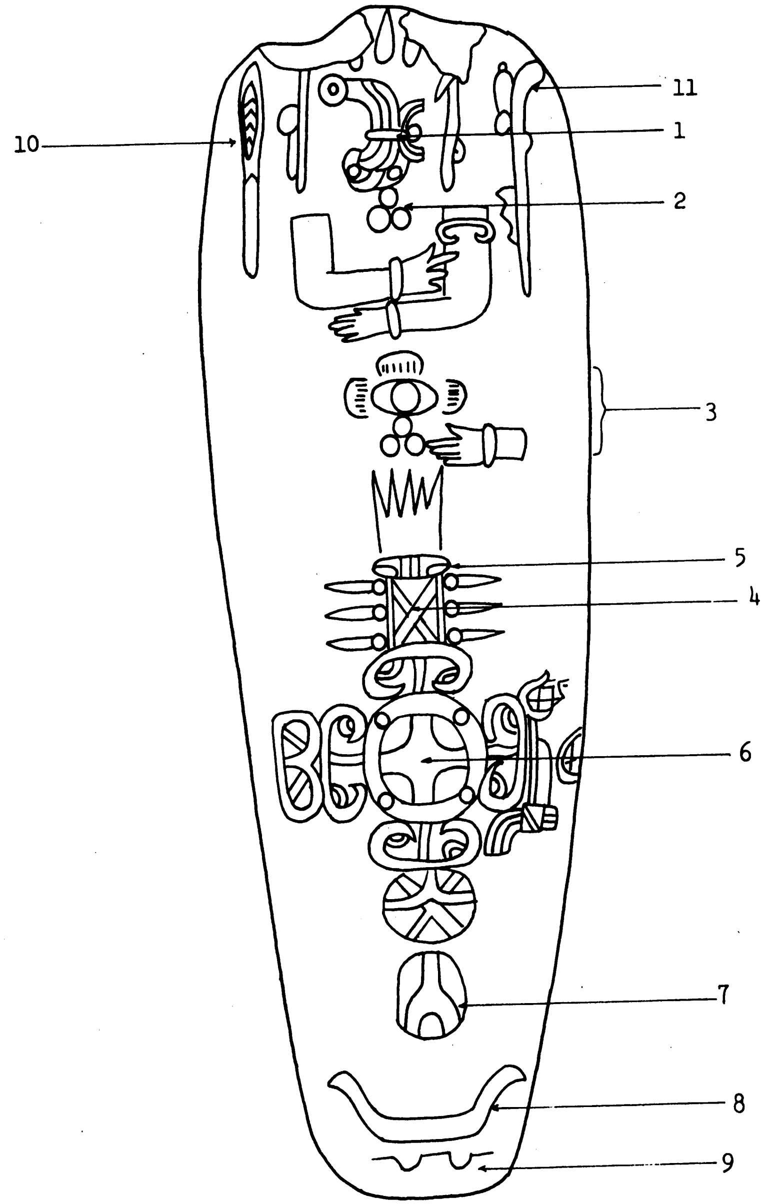


Fig. 36. The Humboldt Celt, provenience unknown. (After Penafiel 1890, pl. 119).

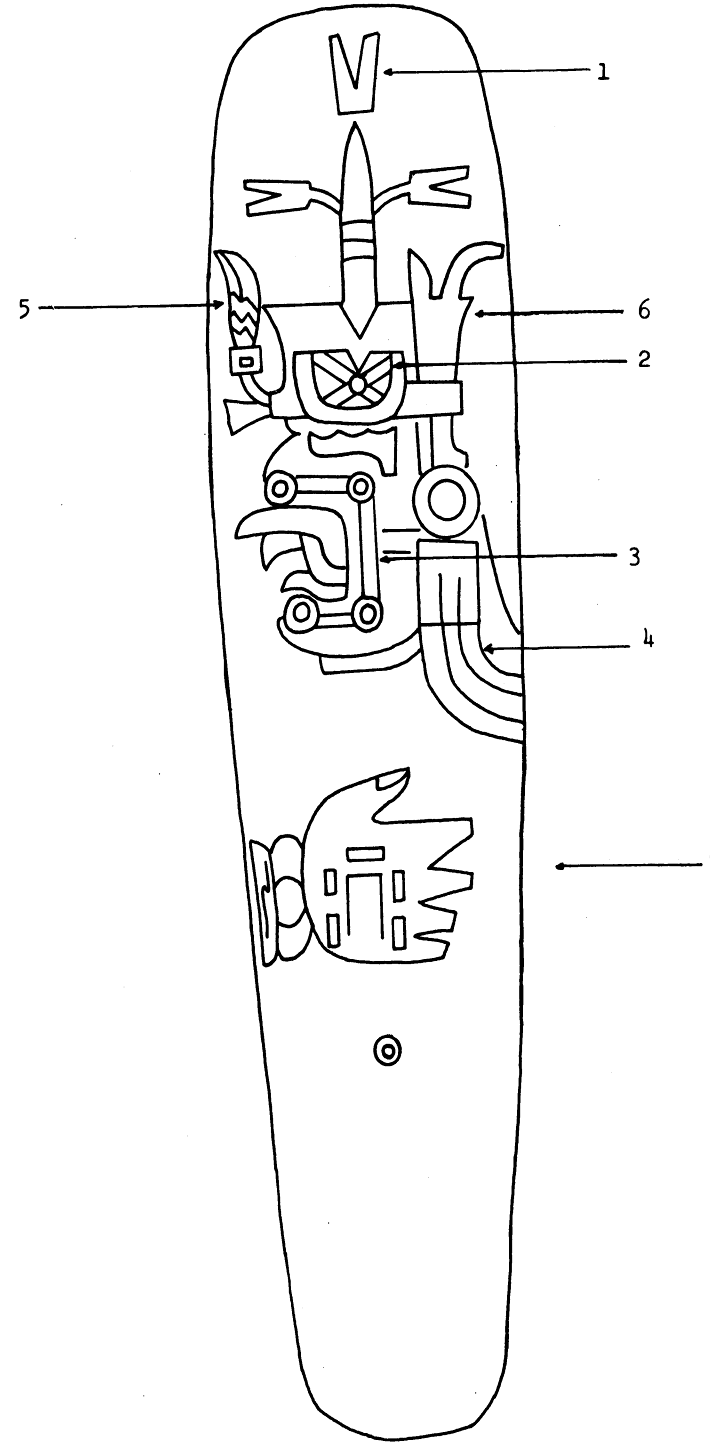


Fig. 37. Jade celt, provenience unknown. (After Covarrubias 1957, Fig. 33, right).

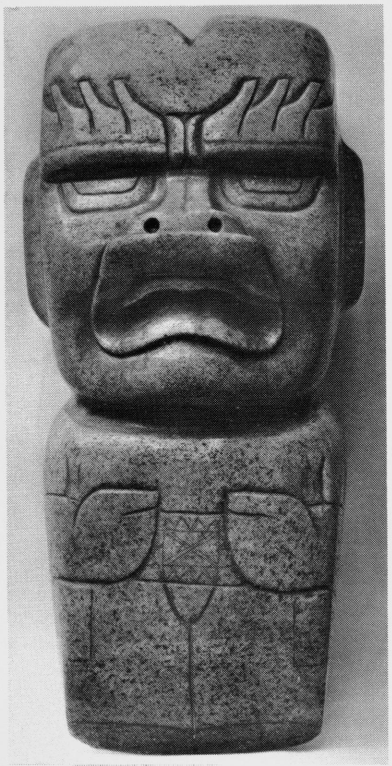


Fig. 39a. Ceremonial jade "axe" from Veracruz, Mexico. (British Museum).

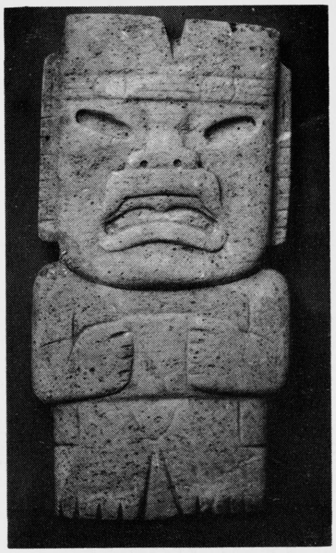


Fig. 39b. Sculptured "axe" from Sanches Magallanes, Tab. In Museo del Estado, Villahermosa, Tab.

Fig. 40a. Sculptured figure from Las Limas, Veracruz, Mexico.

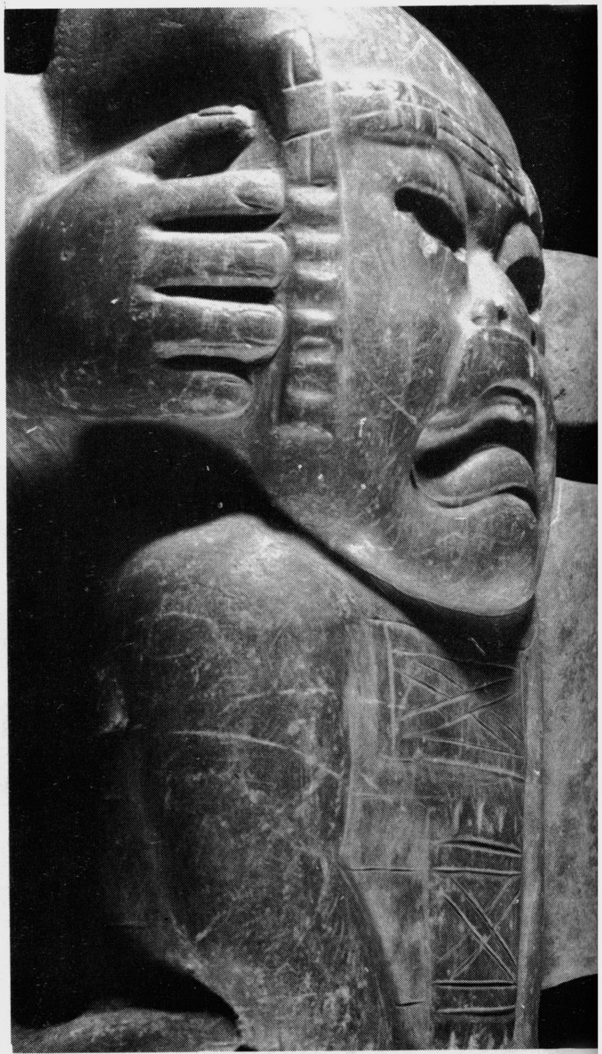


Fig. 40b. Close-up of infant held in (a). Photos by C. W. Clewlow, Jr.

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