Patterns in the Sky

An Introduction to Ethnoastronomy

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Preface

This book is written with the reader in mind who has an interest in things astronomical, but not from the perspective of high-powered telescopes or advanced physics. It should also be of interest to anyone seeking non-Western perspectives on the cosmos, especially those of smaller-scale indigenous societies. As a college professor, I have crafted the work especially for accessibility and utility in the classroom. I'm especially hopeful that this work serve as a practical introduction, such that its readers will seek further knowledge on the peoples, topics, and perspectives it discusses, and offer the numerous references cited as help in that effort.

As an introductory text, this is not intended as an exhaustive study. Astronomy, as a cultural construct, is fundamentally integrated within a specific culture. To fully appreciate a specific people's astronomical system, therefore, it would be best to engage it as part of its complex cultural whole. Since such a particular cultural context and perspective is outside of the scope of this work, however, I direct the interested reader to my earlier book on the Bororo (*Space-Time of the Bororo of Brazil*), and to the many other relevant and culturally detailed works cited in the following pages.

Because systems of astronomy are so fundamentally inspired by the location, especially latitude, of a society, cultural examples are provided from as broad a range of latitude as possible. There is a decided preference, however, for specific cultural details from indigenous peoples of the Americas. Effort has been made to cite primary sources of actual fieldwork and recorded firsthand observations, but this was not always possible.

The treatment of pertinent astronomical and anthropological concepts is purposefully kept to a pragmatic level for the general reader. Technical terms are highlighted in boldface-italics in the text and are defined in the glossary immediately following the concluding chapter.

The detailed table of contents and index should help locate particular material of interest to specific readers. A limited selection of illustrations are included to aid in the grasp of key astronomical concepts, while the text itself is intended to stimulate student visualization and experiential learning through the chapter-specific exercises.

Ethnoastronomical inquiry involves intensive ethnographic fieldwork. A chapter on the main methodologies and pragmatics of such fieldwork is included in an effort to introduce proper and productive procedures and attitudes to potential fieldworkers and to help readers appreciate the process of producing much of the information included or cited in the text. This chapter is not intended as a complete guide for such fieldwork, however.

Each chapter is preceded by a brief passage descriptively presenting a relevant field experience or native story in an effort to link readers more personally with a non-Western cultural reality. I also make use of many ethnosemantic terms. In presenting such non-English words, I have occasionally simplified their original orthography. When dates are mentioned, the more culturally neutral BCE (Before the Common Era) and CE (Common Era) are used rather than BC (Before Christ) and AD (Anno Domini), respectively. Throughout the text I have attempted to write in a stimulating and engaging style for the nonspecialist, while nevertheless maintaining the accuracy of the technical explanations and the integrity of the cultural systems.

Introduction

As the mission jeep splashed away down the muddied trail, my wife and I were left standing with our few bundled possessions among a group of inquisitive Bororo villagers. Around us were the palm-thatched houses that formed the village circle of what was to be our home for the better part of a year, hundreds of kilometers from any town. We were in the middle of Brazil, and the entire tropical savanna seemed sodden beneath the solid gray of rainy-season skies. There was the rich smell of damp soil and wild things, an Earthiness shared by the silent forms around us. Muscular men, stout women, and their fidgeting children peered and stared at us with curiosity, disdain, or feigned disinterest marking their dark features.

In the Portuguese we shared as the bridge between our different native tongues we exchanged greetings and pleasantries, and a few hands reached out to touch us and our things. Skeletal dogs sniffed aggressively, intent on their single objective of finding some food, and bugs with the same purpose descended upon us in hordes, clouding about our eyes, ears, nose, and mouth, quickly turning every inch of exposed skin into an itching complaint.

It was while we were still there in the cleared space of the village plaza, with the fading whine of the jeep's engine and before our belongings were unpacked or even before we knew exactly where we'd be spending the night, that I was asked the first serious question by an elder of the village:

"Is it true that men have walked on the moon?"

This book is an effort to guide its readers to a more active awareness of and interaction with astronomical phenomena, while stimulating greater understanding and appreciation of native peoples' knowledge of and relations with the sky and its marvels. To do so I have relied on astronomy as observed by indigenous peoples of the Americas, owing to the limitations of scope and length of this book and to my own research experiences and familiarity with published sources. Nevertheless, the keenness of observation and the richness of native knowledge in this

broad geographic area, added to what is known of the significance of astronomy in such ancient cultures as those of Egypt, China, Babylon, and Neolithic Britain (see, for example, Aveni, 1989a and b, 1993, and 1997; Krupp 1978) indicate that astronomical observations and their application in cultural systems are very often fundamental to human cultures.

To adequately access, describe, and explain a system of astronomy, we need to "ground" (or, if English permitted, to "sky") ourselves in certain astronomical basics. I provide a concise overview of these basics in a general chapter and in specific chapters devoted to particular celestial phenomena. I hope that practical knowledge will be gained from actual naked eye astronomical observations, as guided by the practical, hands-on exercises and stimulated by the crosscultural examples. In this way, astronomical "facts" can be acquired, along with a growing awareness of other cultural perceptions of these facts.

Many previous crosscultural treatments of astronomy have been published (see for example, Arias de Greiff and Reichel de Von Hildebrand, 1987; Aveni, 1975, 1977, 1982, 1989a or b, 1993, and 1997; Aveni and Urton, 1982; Benson and Hoskinson, 1985; Krupp, 1978; McCaskill, 1987 [1989]; Miller, 1997; Williamson, 1981, 1984; Williamson and Farrer, 1992, to name but a few). This current work differs from these in that I have organized most of the chapters according to specific astronomical phenomena, and then proceeded to provide pertinent crosscultural examples of these phenomena. This organization, combined with the learning scenarios and an overview chapter on ethnoastronomical field methods are all intended to help make this book a practical, introductory guide to doing ethnoastronomy.

WHAT IS ETHNOASTRONOMY?

Since our beginning as a species, people around the world probably have had a strong interest in the sky and its many important and fascinating phenomena, as indicated by the Bororo elder's concerned query. After all, any time you stand outdoors, reasonably free of towering natural features or cultural structures, you are surrounded by the sky in all of its paradoxical enormity. Clouds cover it, rain falls from it, stars dot it, the sun and moon shine from it and move across it, trees grow up to it, and birds fly through it. If you spend any significant amount of time outside at all—as we did during our ten months of field study among the Bororo Indians—the sky is in your face night and day.

Not only is the sky there and in your face, but its features profoundly affect your life and what you do. Most of us still distinguish between our daytime and nighttime activities for example, and these activities have logical and historical connections to the alternating periods of light and dark—our day and night—controlled by the apparent rising and setting of the sun. In fact, our very biology has been programmed to some extent in adapting to this repeating day and night phenomenon in measurable ***circadian rhythms***. And while our modern science of meteorology has come to identify numerous influences on our weather, the basic seasonal patterns of sunshine, winds, and rain still are linked generally to the sun's apparent annual motion. Nature's cycles occur in synchronous rhythm with this celestial periodicity, and any people who rely on the natural world for survival—and we only kid ourselves if we think we do not—must synchronize as well.

Today, if you wish information about what is going on weather-wise or in the sky, you can dial up information on your phone or via the Internet, turn to your local weather forecast on cable TV or the radio, or read about it in some section of your local newspaper. Data on the official time of sunrise and sunset has all been precalculated, and you can look for astronomical information in *Sky and Telescope* magazine, an almanac or other published aids, or take a college astronomy course.

But what do people do who do not have access to these resources, or who perceive the sky and its features differently from the way we do here in the United States or in Europe, in the modern West? How do other people see and understand the sky, what goes on in it, and its relationship to what happens here on the surface of the Earth? The process of finding out the answers to these questions is known as ***ethnoastronomy***: the study of how people who do not ascribe to modern Western astronomical paradigms perceive, understand, and make use of their knowledge of the sky and its phenomena. A well-planned and executed ethnoastronomical project is both anthropological and interdisciplinary and ideally proceeds in a holistic manner.

Ethnoastronomy is anthropological in that it attempts to help us to understand better what it means to be human and cultural beings and does so with crosscultural sensitivity. It is also anthropological in its reliance on ethnographic or field research techniques such as participant observation and ethnographic interviews pioneered and refined by anthropologists. ***Participant observation*** is a field methodology that attempts to balance direct and informed observation of a people's daily life with active participation in it, real experiential learning. This process allows for the formal interview to evolve into informal and substantive conversations and dialogues.

Ethnoastronomy is also interdisciplinary, since it is best carried out with some formal training in both anthropology and astronomy, and since its subject matter can be related to so many different interest areas and disciplines, such as economics and subsistence practices, religion and ritual, philosophy, folklore, social organization, and politics. Because of this interdisciplinarity of the topic, and because from an anthropological perspective cultures can be said to be integrated in the way their component parts interconnect, an ethnoastronomical

study is likely to be most productive when carried out holisitically: when astronomical details are not studied merely for their own sake but are related with sensitivity to other pertinent areas of that culture.

Ethnoastronomy is related through shared subject matter to ***archaeoastronomy***, the archaeological and historical study of a people's past astronomical knowledge and related practices (see Baity, 1973 for additional, earlier definitions of both ethno- and archaeoastronomy, and the pertinent discussion by Farrer and Williamson, 1992). The research techniques most often employed in archaeoastronomy include measuring building alignments and sightlines and studying ethnohistorical documents or cultural artifacts. It is another sub- or interdiscipline, most often associated with the study of either defunct cultures (such as pharaonic Egypt) or prior phases of cultures still extant (such as the Maya and their Classic era in the first millennium CE). But the related subject matter also means that basic techniques sometimes can be shared productively in both ethnoastronomical and archaeoastronomical studies (such as in my own work among the Bororo, 1982, 1992, 1994 [1995]; Urton's study in Misminay, Peru, 1981; and the Tedlocks' work among the Maya, 1992, 1996, 1999). It is much more productive to consider the two types of study as related and overlapping, complementary parts of what can be called "cultural astronomy" (for a general discussion of cultural astronomy see Ruggles and Saunders, 1993).

Chapter One

Getting to Know the Sky

The Basics

In the tropical savanna, twilight deepened quickly. Sounds of the day both in the village and beyond it changed tone and tempo. One set of biting, airborne pests replaced the other, and the villagers relaxed from their busy daytime tasks into more leisure evening activities.

"*Awuri makarega!*"

In his high sing-song, the Bororo village elder made his traditional cry, calling our attention and our presence. Men grabbed their mats and sauntered as shadowy silhouettes against the darkening sky to the western plaza of the village. There they spread their mats and lay prone on the cleared sandy ground, facing the afterglow of sunset and basking in the warmth of the sun-soaked earth. Cigarettes were lit and comments shared, sometimes to and from the clusters of women and children sitting outside the western arc of houses. The crier again raised his voice, talking of the day's activities and plans for the morrow over the quiet undercurrent of muted conversation.

A hushed silence followed, and then another elder's voice was heard: He told a story, an old story, a story of culture heroes and of time before and yet still now, of relations and actions and places, all known and familiar. Entranced by his voice we shared the drama of the tale, lazily waving fans of plaited palm while dogs and youths jostled for space among and around the inert male forms.

And as the story is told, and before it began and after it ends, the men lay on their backs in the plaza, looking up at a clear and crystalline sky with its myriad shimmering and colored points of light. The men lay there and beheld the stars and knew them, as untold generations of Bororo males had beheld and known them.

There is no surprise to the fact that most of us in the modern West know and relate to the sky as poorly as we do. Unlike the Bororo, who

spend most of their waking time directly under the sky, alert to its various phenomena and manifestations, for us

> the skies are often smog-blanketed and otherwise obscured by towering edifices and the beaming, flashing, glaring lights that transform much of a city's night into artificial day. The rhythms of our modern world have changed, with seasonality and the observed coursing of celestial entities less crucial than business hours, banking hours, the flux of the stock exchange, and tax deadlines. (Fabian 1992:1)

To understand and appreciate fully how peoples outside of the modern West in either time or place perceive the sky, we must go beyond our astronomical ignorance. This is not a simple task, but if you have access to any observable sky and sufficient time to make periodic observations, the attempt will be well worth the effort. Entire new worlds of perception and information will open to you.

To get the most out of a crosscultural or ethnographic study of astronomy, it is necessary to have some basic knowledge of what is going on in the sky, some explanation of celestial mechanics. Few people would attempt to study an indigenous musical tradition, for example, without some formal training in music (and if they did, it would be with questionable success). While hoping to keep our minds and eyes receptive to systems of astronomy different from our own, we nevertheless need a practical understanding about motions and patterns in the sky in order to make a study of some other astronomical system truly productive. Since different peoples will have different perceptions of and explanations for celestial phenomena, learning the basics of astronomy with the naked eye within our own system can serve as a reference point from which to understand and compare other systems.

ASTRONOMICAL KNOWLEDGE AS FUNDAMENTAL

What time is your next class or that appointment you have to keep? On what day of the week did you say you would meet your friend for lunch? When does the semester end? Isn't it the weekend yet?!?

We may ask ourselves or others common questions like these daily, and yet we never stop to think how it is we know the answers. Sure, the wristwatch or wall calendar may give us the information we need, but where do those numbers and dates come from? What does it mean to be "10:00 A.M." or "noon"? How is it that today is a Wednesday, or the sixth of May? What do these names and numbers mean, and where do they come from? Whereas answering this in detail is beyond the scope of this book, suffice it to say that ultimately all such matters of time and date are tied to our Western concepts and knowledge of astronomy and the workings of the celestial sphere overhead. (For a more detailed answer that goes beyond information in the following chapters, read *Empires of Time* by Anthony F. Aveni.)

If you are a Temperate Zone farmer, you know how important good timing is to your livelihood. If you plant too early in the year, you may risk a late frost; too late, and it might get too dry, or an early freeze may hurt your crop. If you did not have a wall calendar or almanac to consult, how would you know when to plant? You would have to depend on your own observations when things seemed or looked right for planting. But would you base this on the weather getting warmer? Sometimes a February thaw comes and seems really spring-like, but how would you know it was still only February? Crops planted then could freeze before the weather truly warmed up. Perhaps you could observe when some of the early buds and blooms appear, but even these can get nipped badly by a late frost due to annual variation.

While making direct observations of events happening in your ecological environment is an important component of timing your productive and subsistence activities, the most regular and repeated annual phenomena are occurring overhead: the regular apparent movements of especially the sun and stars. Over time, careful observations of these regular phenomena—where the sun is rising or setting, for example, or what stars are just appearing or perhaps which are most overhead at sunset, midnight, or sunrise—would be your safest bet to knowing when to plant and miss the frost, based on making such astronomical observations in connection with when frosts have occurred over the years. Here in the United States, our National Climatic Center has already done this for you, and you can look up the first and last frost dates for your area in the readily available *The Old Farmer's Almanac*. In southern Indiana, for example, I do not want to plant my little house garden of vegetables before mid-April, after which I can count on about a 190-day growing season before the first frost of the fall. The Classic Maya (Aveni, 1980) and ancient Egyptians (Krupp, 1978) had their own almanacs for just such purposes, an important bureaucratic responsibility functionally significant to keeping their large populations fed.

This is fine for those growing our food. But food production—farming—has only been going on for the last 10–12 thousand years, and then not everywhere nor by all peoples. How important is calendar-type knowledge for food foragers, those who are hunting, gathering, and fishing for their food and other resources? Again, animal and plant cycles are seasonal, and seasonality is most fundamentally tied to the sun's apparent cycle. Most animals breed and give birth at specific times of the year, for example, while fish migrate and spawn seasonally, and of course flowers and fruits appear in their own time each year. If you have

hunted, then you already know that there are fixed hunting seasons currently in the United States, which at least in part intend to be sensitive to game and their breeding cycles (e.g., deer fawn or give birth in May–June in southern Indiana, but active hunting is legal only in the late fall [Richard Davis, Park Naturalist, personal communication, May 1998]). While to some extent food foragers will exploit their resources circumstantially as they occur, the most effective use of natural resources is to know what is most available when and where—migrating caribou in the far north for example, returning salmon in the Pacific Northwest, or berries in the eastern Woodlands. Although astronomical observations are not the only nor necessarily the best guarantors for marking such cycles, in their annual regularity they provide a valuable gauge or checkpoint. The Crow Indians, for example, traditionally used the spring appearance of the constellation Báakkaalaxpitchee, or "Bear Above" (the Western Hercules constellation), to know it was time for trapping immature golden eagles for their prized tail feathers (McCleary, 1997:22).

In the most basic of ways, knowledge of the regular movement and patterns in the sky enhances a people's survival and livelihood. It is knowledge that is fundamental to coordinating, integrating, and synchronizing life within a natural environment, and this is important information for all of us to know: all of our lives depend on what is happening up there and how it affects us down here. Furthermore, the astronomical knowledge of a specific people, such as among the Skidi band of Pawnee, may help define that people's very identity (Chamberlain, 1982). Besides in subsistence pursuits, astronomical observations are also put to other practical and cosmological uses, such as the patterns of residences or other structures and their alignments; the configurations and orientations of whole social units; models for or coded messages on essential cultural values; mnemonics for, or texts of, or even as prominent figures in, native folklore; and ways to connect with cosmic beings perceived to be the repositories of great power.

Besides the fuller grasp of such essentials, the crosscultural study of astronomy offers itself with essential formal properties that should facilitate comparative approaches and exchange. As R. Tom Zuidema (1981a:29) has argued:

> All people observe the same primitive elements in the sky: sun, moon, and stars . . . On this primitive set of concepts people have built astronomical, cosmological, and calendar systems with as much variation as they have with kinship systems. We should be able to analyze the former systems, therefore, with the same rigorous and theoretical detail as the latter.

In other words, kinship systems, long a fascination of anthropologists, are a great subject for crosscultural study, due to their fundamental significance to society as well as to their limited and shared set of principal elements of parents, children, and siblings, which facilitates comparative research. Studying astronomical systems crossculturally similarly lends itself to comparative research due again to their shared set of basic elements. As such, ethno- and archaeoastronomy provide vital information in our efforts to understand cultural variation within our single human species.

ASTRONOMICAL KNOWLEDGE AS CULTURALLY INTEGRATED

A people's astronomical knowledge is often fundamentally tied to economic and other productive pursuits within their natural environment, which is in itself an important enough reason to learn about it. But in fact, astronomical knowledge does not stop there: in many societies it is richly integrated in multidimensional ways with various facets of life. Anthropologists explain this in part by understanding that cultures in general are "integrated": that is, important connections are made between the way people make a living, organize themselves, and think about who they are. How this happens with astronomical knowledge is truly fascinating.

Among the Bororo, for example, Meri (Sun) and Ari (Moon) are celestial bodies, but they are also brothers and culture heroes who figure prominently in many folktales. They are related or belong to a specific clan that has, as part of its official "charge" and privilege, the responsibility to properly locate and orient the village. Not surprisingly, each Bororo village is ideally oriented with its main axis due east and west—the principal axis as well of solar and lunar apparent motion—with Sun and Moon's clan immediately adjacent to this line (Fabian, 1992). Elsewhere, stars serve as the Skidi Pawnee model for a council of chiefs (Chamberlain, 1982); the planet Venus is a deity who both empowers the sun and rises from its ashes, and is representative of an entire Classic Maya philosophic school (Aveni, 1989a; D. Tedlock, 1996); and sun and stars together, integrally associated with cardinal directionality and seasonality, serve the Mescalero Apache as the essential "base metaphor . . . the organizing principles around which Mescalero Apache life is predicated and around which such life is judged" (Farrer, 1991:17).

Astronomical knowledge is often intimately connected to how peoples not only keep and mark time and use this for their productive and extractive activities, but also with how they perceive, understand, and organize their entire world. Patterns in the sky are important in a dialectical process in which humans perceive in nature patterns that reflect their sociocultural systems; but humans also make observations

of natural phenomena such as patterns in the sky and use these to inspire and fashion their sociocultural movements, relationships, and patterns on the ground.

Chapter Two

The Sun

Among the Bororo, Meri (Sun) is known as older brother to Ari (Moon), and the two of them, often referred to as Meri-doge (plural of Meri), traveled together, sometimes playing pranks on the Bororo.

One day, after many encounters with the Bororo, the Meri-doge were thirsty. They stopped at the house of members of the Iwagududoge clan (localized on the southwest arc of the village circle of houses) who were associated with large aquatic birds (*karawoe*). The Meri-doge asked for water, which was kept in large and heavy ceramic jars. Knowing the brothers' mischievous inclination, the Karawoe were reluctant to let them handle the valuable water jars. When Meri picked up a jar to drink, his hosts said: "Father, do not do that, you will break the jar."

"No, I will not break it."

But no sooner had he said these words when the jar slipped from Meri's hands to the ground, breaking into many pieces.

"We told you that you would break it!"

Hearing their angry complaints, Meri and Ari fled, pursued by the Karawoe who caught them and brought them back to their house. The Meri-doge were made to sit next to each other in the midst of the Karawoe, who began to fan them with fans of plaited palm.

The Meri-doge complained: "Don't make wind like that."

But the Karawoe replied, "You produce a lot of heat."

And they kept fanning with so much force that Meri and Ari were lifted by the wind into the sky.[1]

There is no regular celestial phenomenon that is so obvious or as consequential for us here on Earth, as the sun. The very life processes of all terrestrial organisms are utterly dependent on solar energy and the rhythms associated with our daily rotation and yearly revolution. Indeed, the sun is such a powerful and obvious natural phenomenon that it is difficult to imagine the native society that has not observed it with great interest.

DAILY MOTION

For us as Earth-based observers, the sun's predominant motion is a daily rising in the east and setting in the west. But its course varies greatly depending on the observer's latitude. For someone on the equator (0° latitude), the sun will appear to pop up out of the horizon and rise straight up, peak high up at noon as it crosses the meridian either north or south of the zenith, and vertically descend to its setting place. Although once off the equator the sun's daily motion may not be precisely straight up and down, the tropical band is characterized by vertical daily solar motion, high noontime sun with very short noontime shadows, and short periods of twilight (prerise dawn and postset dusk).

By comparison, in the Temperate Zones the sun's daily path forms more of an acute angle with the horizon. The sun rises more gradually as it slides along the horizon, climbs at a slant to its noontime meridian peak, which will always be either north or south of the zenith depending on the hemisphere (south or north, respectively) of the observer, then coasts back down its descent ramp, skimming along the horizon to its eventual set. While the angle of motion is much more acute near the northern and southern temperate fringes close to the Arctic and Antarctic Circles, in general the Temperate Zones are characterized by slanted daily solar motion, medium-high noontime sun and noticeable noontime shadows, and extended periods of twilight.

The far north and south or Frigid Zones have few permanent residents: most of Alaska and Canada is still technically temperate, and Tierra del Fuego, South America's southern tip, is short some 10° from the Antarctic Circle. Residents north of the Arctic Circle observe the daily motion of the sun as a flattened path circling around the sky rather than traveling up and down. The sun will be low in the sky, will skim along the horizon at and near the equinoxes, and will not be visible at all for some time on either side of the solstices (December in the north and June in the south). Here the sun stays low and shadows are long, with prolonged periods of light, twilight, and darkness alternating throughout the year.

THE SOLAR YEAR: SOLSTICES, EQUINOXES, AND THE SEASONS

It has already been mentioned that the Earth is tilted on its axis about 23.5° to its plane of revolution, and that it pursues an elliptical revolution around the sun that takes about 365 days (closer to 365.24).

Because of these factors, the daily motion of the sun as we perceive it varies over the course of a year. As the sun pursues its yearly travels along the ***ecliptic***, its apparent path against the stars, at different times of the year it is either higher or lower in the sky, further north or south, and the days (or nights) are longer or shorter.

Our Western (Gregorian) calendar identifies four seasons or divisions of the year considered "natural" in the temperate zone in which our modern calendar developed. The four seasons are reckoned informally by changes in weather patterns and are associated culturally with season-specific activities. Astronomically, the four seasons currently recognized are marked by the sun's position in its northern and southern extremes, the solstices; and near its midpoint between these extremes when day and night time are approximately equal, the equinoxes. The term ***solstice*** derives from the Latin for "sun" (sol) and "to stand" (sistere), an expression that nicely describes the sun on and around June 21–22 and December 21–22, the dates for its northernmost and southernmost extreme positions, respectively. For several days at these times in the year the sun will appear to rise and set in the same places and attain the same altitude at noon. This apparent "stand still" occurs after the sun can be seen approaching these limits either along the horizon or via its height at noon as measured by shadow casting.

After reaching either solstitial extreme the sun begins to reverse its motion, slowly at first with very little difference in its rising or setting location or its path in the sky. Gradually, the sun seems to quicken its pace until near the ***equinoxes***—on or around March 22 and September 22—when its daily rising and setting locations are farther apart, as is its height in the sky. After this, it will again gradually "slow down" as it approaches the opposite extreme. These north to south peregrinations of the sun are directly responsible for seasonal phenomena, and are noted with interest by many native peoples. Bororo elders know the sun's horizon extremes as seen from the village plaza, and several Bororo myths recount travels of the Meri-doge, the sun and moon as anthropomorphized culture heroes.

For observers in the north Temperate Zone, winter begins on or near December 21. On this date night is the longest and daylight the shortest, and the sun courses relatively low in the southern portion of the sky, even at noon; for an observer at 40° north latitude (N), for example, the altitude of the noon sun at the December solstice will be only about 26.5°. Nights get shorter and days longer as the sun moves northward. On or around March 22, the vernal equinox, which begins our northern spring, the sun rises approximately due east and sets due west, and daytime and nighttime are approximately equal (equinox derives from the Latin for "equal night"). On the equinox, the noon sun for our same 40° N observer will have an altitude of about 50°. Continuing its move northward along the horizon the sun is also observed higher in the sky. The sun gradually achieves its northern extreme on June 21–22, and summer officially begins. As it "stands still" in June, its altitude at noon observed from 40° N will be about 73.5°. We will then see the sun swing back to the south, through its east-west position of the September equinox on or around the 22nd (the beginning of our fall or autumn), after which the shortened days and lower daytime sun become more obvious, until winter officially begins again with the December solstice.

Solstice extremes are important to many temperate peoples. Although New Year celebrations in our Gregorian calendar may seem impractical for northern temperate dwellers caught in the cold and snow of early winter, how fitting it seems to celebrate a new year once the sun has definitively turned in its course. Northern latitude observers see the sun progress ever southward in December, as the days shorten and the cold of winter arrives. With several winter months ahead, what a relief to observe the sun cease its southward course and begin again to advance northward, with the promise (at least) of a warm spring and summer yet to come.

The Tewa, a Puebloan society in the U.S. Southwest, celebrate the "days of the sun," the "final work of the year," in mid-December, which is "a winter solstice and new year rite in which the whole community participates" (Ortiz, 1969:102). Boas reports that for some Central Eskimo (some of whom are above the Arctic Circle), a type of "new fire" ceremony is practiced around the time of the December solstice (1888:607–8). In Washington State, in the Northwest Coastal area, the native Quinault are described as setting up observation "seats" from which to observe solstice sun rises and sets. While the June solstice went unnamed, the "winter solstice was called xa'Ltaanm (comes back, the sun) (Olson as quoted in Miller, 1992:194). At this time, Quinault whalers "made contact with their supernatural patron" (Miller, 1992:195). McCleary (1997) reports that for the Crow the winter or December solstice is traditionally "a time of social and religious significance" and a time when special social winter dances are held (103).

June solstice, as the time when the sun is highest and the days are longest, is also an important time in traditional northern calendars. For Northern Plains Indians, the June solstice was the time for a religious ceremony of great importance, the Sun Dance. As Black Elk describes it, it was a dance "to purify the people and to give them power and endurance. It was held in the Moon of Fatness [June, more or less] because that is the time when the sun is highest and the growing power of the world is strongest" (Neihardt, 1979 [1932]:96). Perhaps for similar reasons the June solstice was the traditional time for performing the Apache girls' puberty ceremony, although today the event occurs for practical purposes during the Fourth of July weekend. That this Apache ceremony is linked to solar significance is clear in the activities of its fourth and last day, especially the blessing time called "pulling the sun": after a full

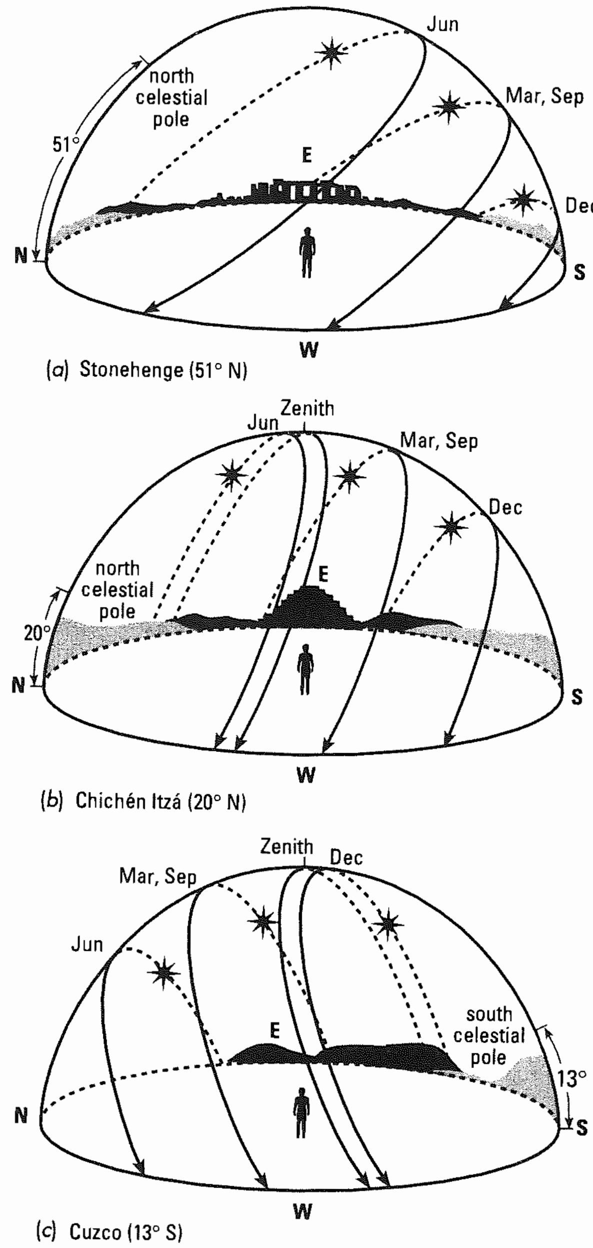

Figure 1. The daily path of the sun on March 20, June 21, September 22, and December 21 as seen from (a) Stonehenge (latitude 51° north), (b) Chichén Itzá in northern Yucatan (latitude 20° north), and (c) Cuzco, Peru (latitude 13° south). Additional lines in (b) and (c) show the path on zenith passage dates.

night of ceremonial activity and nearing sunrise approaches, "as the last verse of the last song is sung, [the singers/ritual specialists] extend their arms over their heads, with their palms, the sun symbols painted on them, open and facing toward the sun." If the timing and singing are correct, "just as the last note of the last morning song is sung, the sun tops the mountains to strike the men's upraised palms" (Farrer, 1996:85).

The solstices together may form a significant marker of annual periodicity, a bisecting of the year. As Hultkrantz (1998 [1987]) describes for the Southwestern Zuni, "the ritual year is divided into two halves separated by the winter and summer solstices. The winter and spring ceremonies are concerned with medicine, war, and fertility; the summer and fall ceremonies with rain and crops" (120).

Observing the solstices as the critical points in the sun's path when it reaches its extremes and reverses its direction is important to many native peoples. Fortunately, since the sun appears to move relatively slowly or change its position minimally in the days preceding the actual solstice, it is a time relatively readily observable in the sun's cycle. What about the equinoxes, the dates we use in combination with the solstices to determine the formal seasons in our contemporary Gregorian calendar? Since the sun is moving rather more quickly with greater daily change in its position in March and September than it is in June and December, are the equinoxes important dates in traditional northern calendars? How are they determined? Chamberlain (1982) suggests that for the ethnohistoric Skidi Pawnee the rising sun on the equinoxes was important in lighting up the interior altars of their east-oriented lodges through a small entranceway (179). McCleary (1997) observes that the Crow hold the equinoxes as "ritually significant" for the first annual splashes of water in the sweatlodge (103). But whether the equinox was determined by or itself determined the east-west direction is unclear. Among the Tewa, the time from the autumnal equinox through the vernal equinox is the period of the year most ritually active, and is contrasted with the heightened agricultural activity from vernal to autumnal equinox (Ortiz, 1969:104–5). On the other side of the world the importance of the equinoxes is inscribed in the Japanese calendar, where to this day the vernal and autumnal equinoxes—historically significant and meticulously observed by Chinese and later Japanese astronomers—serve as national holidays.

THE TROPICAL SUN: ZENITH PASSAGE AND ITS COMPLEMENT, THE NADIR

In the Tropics, the sun also is observed to sweep between northern and southern horizon extremes and relatively high and low noon positions overhead, but with some significant differences to the picture as presented for the Temperate Zone observer. Whereas for the northern observer the sun is at its lowest at the December solstice, for the tropical but southern latitude Bororo—who inhabit areas of Mato Grosso, Brazil, between about 15° and 19° South Latitude—the noon December solstice sun stands at over 80° altitude, south of the zenith. As it turns around on its return trip to the north, the noon sun actually gets higher, peaking at noon in early February at the zenith itself, casting no shadow from upright objects at noon. It descends from the zenith daily after that, but is still over 70° high at noon at the March equinox, now to the north of the zenith. Its lowest noontime height, during the June solstice, still has it at over 50° of altitude in the northern sky. The sun will then pass again through the zenith in November en route to its southern December solstice extreme.

The Bororo orient their most prominent and ritually significant structure—the *baimanagejewu* or "house in the center"—with its longer sides facing due east and west along their major village axis. In premodern times, specific Bororo clans were designated to locate and orient their villages, and did so by careful solar observations, among other considerations. This relationship is encoded in the Bororo social system with Meri, Sun, a member of one of these clans, located immediately adjacent to the village's east-west axis. Some Bororo today remain well aware of the northern and southern horizon extremes of the sun's annual movement and are close observers of the path of the sun, which they call *meri etawara*. The sun is still used for telling the time of day, especially through the simple but effective method of pointing the entire hand, palm down, to the sun's position. By doing this and stating "*Meri woe*" ("[When] the sun [is] here"), they can easily plan or coordinate an action for a specified time. The Bororo also have a well-developed concept of the zenith, which they call *baru oia*, "the center of the sky." (Unfortunately as far as Bororo zenith sun observations are concerned, in November and February when the sun is in their zenith, the sky is often under the heavy cloud cover of the rainy season, and I was unable to record any data specific to this phenomenon during my field study.)

The solar zenith passage was of considerable significance to the archaeologically and ethnohistorically known Mayas and Incas, for whom these phenomena played critical roles in cosmology and calendar (see for example, Aveni, 1989a, 1997; Zuidema, 1981b). The Maya of the Yucatan peninsula, for example, at least at the time of conquest, seemed to be using one of the sun's passages through the zenith (probably in mid-July) as their determinant of New Year (Aveni, 1989a:237). Significance of zenith passage continues into the ethnographic present. Aveni reports (from R. Girard) that among Maya in both Honduras and Guatemala, observation of the zenith sun is important in forecasting weather and activities pertinent to their agricultural cycle, and the "elaborate" rituals that accompany these solar events (1980:40). This correlates favorably with Barbara Tedlock's work among contemporary Maya, whom she reports using solar zenith passages "to fix dates in the agricultural calendar" (1999:44) and her interpretation of primary directional significance for the Maya as "east, zenith, west, nadir" (B. Tedlock, 1992:173). That tropical peoples interested in zenith sun passages (and other zenith phenomena) also should be interested in the nadir is logical. The ***nadir*** is the point diametrically opposite the zenith, beneath the observer. Of course, the obvious difficulty here is that no empirical observation of astronomical bodies actually passing through the nadir is possible for an earth-based observer. Discussion of nadir crossings is, therefore, essentially theoretical. (Attentive to this, Zuidema, 1981b, has employed the term ***anti-zenith*** in his analysis and discussion of nadir-related phenomena in his works on the Inca.)

In his work among Quechua-speaking natives (*runa*) in Misminay, Peru, Gary Urton (1981) found a number of references to zenith passage for calendrical purposes, but not only of the sun: a variety of celestial phenomena (e.g., specific stars and the Milky Way, covered in chapter 4) also were observed in association with a zenith crossing. In Misminay the sun is observed for decisions on when to plant, and in this somewhat complicated combination of astronomical observations, field research, intellectual inquiry, and deep context cultural meaning we find significance of both the zenith sun and its nadir passage. The growing season of maize in Misminay is from seven to eight months, but at its altitude the danger of frosts threaten crops planted either too early or too late. Planting, at least of the important maize crop, must therefore occur locally between August and October, a period of time the Misminay runa designate through solar observations as the "center-sun." This period of time is precisely bounded by the sun when it passes through the nadir at midnight in mid-August and through the zenith at noon at the end of October, dates associated with sunrise and sunset observations as seen from Misminay (Urton, 1981:69–77). As summarized by Urton, "the limits of the center-sun/planting-sun in Misminay are calculated fairly precisely to provide for the survival of crops . . . the limits of the 'center-sun' may correspond to the four points of the zenith and nadir sunrise and sunset" (76). Urton's work on these topics was stimulated by R. T. Zuidema's pioneering work on the calendrical significance of zenith and nadir passages of the sun (and moon) to the Inca (see e.g., Zuidema, 1981b), who were in political control of the area of Misminay at the time of the Spanish conquest.

THE MIDNIGHT SUN AND NIGHT AT MIDDAY

An observer above the Arctic Circle sees the sun move in flat planes around the sky. Not only does the sun never near the zenith, there will be times when it circles the sky without setting, and other times when it will not rise at all.

For the Inuit at Igloolik, Canada, at slightly less than 70° N, "the sun is below the horizon for forty-six days between 29 November and 14 January and above the horizon for sixty-six days between 19 May and 24 July" (U.S. Naval Observatory, as reported in MacDonald, 1998:11). The extended period of night is called Tauvikjuaq, "Great Darkness," and is associated with poor hunting and dangerous travel. During this fearful time extra supernatural protection was sought by the Inuit through ritual and the recitation of sacred words (MacDonald, 1998:101).

On the other hand, the return of the sun in mid-January (an occurrence affected by unpredictable effects of ***refraction*** of sunlight in the thick atmosphere near the horizon) was often met by the ***Arctic*** Inuit with "exuberant festivities" and new fire ceremonies, when all old lights would be put out and rekindled (MacDonald, 1998:107–10). It was also a time for making long-term weather forecasts, based on observations of the sun's reappearance vis-à-vis the first new moon of the year (111).

SOLAR ECLIPSES

A ***solar eclipse*** is the ***conjunction*** between the moon and sun, and so can occur only at the time of astronomical "new" moon or that time each synodical month (the month of lunar phases, discussed in chapter 3) when the moon is otherwise not visible to us. Since the moon as viewed from the Earth appears to be coincidentally the same diameter as the sun, a total solar eclipse can only occur with an exact alignment of the sun, moon, and Earth, and then will be visible from only a small portion of the Earth's surface. Solar eclipses, therefore, happen rarely for residents of any specific geographic area (although technically they occur more frequently than lunar eclipses [Aveni, 1980:78]). It is even rarer to have such an occurrence as observed by native peoples reported by a trained ethnographer. This is unfortunate, since the daylight darkening and nocturnal sensation produced by a total solar eclipse is quite sensational.

Meri bi or "death of Meri" is how the Bororo refer to an eclipse, and the Salesian missionaries report that it is cause for "great terror" as it is perceived to foretell death and misfortune (Albisetti and Venturelli, 1962:791). A *bari* shaman, one of two types of religious specialists among the Bororo, will attempt to intercede with the spirits believed to be causing the effect, as well as read the omen in its application to his village. The Timbira north of the Bororo interpret a solar eclipse as a struggle between Sun and Moon, described in myth as two primordial males who discover each other and exist in a competitive relationship (Nimuendajú, 1946:233, 243–44). Apparently nothing active is done by the Timbira when one occurs—which contrasts with their reaction to a lunar eclipse (see chapter 3)—but anxious waiting. Misfortune is also feared by the Maya during either solar or lunar eclipse (B. Tedlock, 1992:184), but it is unclear if any specific behavior is associated with the event.

In temperate North America, the Tewa of the U.S. Southwest apparently dreaded a solar eclipse, deeming it a sign of displeasure of their Sun Father with them, signaling his possible departure forever from the sky. Their response was to devise a ceremony of propitiation and prayer (Williamson, 1984:189). Also in the Southwest, the Navajo, while calling a solar eclipse "death of the sun" like the Bororo, see less dread in its occurrence. They believe it to be a sign of imbalance in the energy transfer between Earth and sun, and while some ceremonial observances may be made, in general the occurrence is considered benign: the sun who has taken the energy of too many lives, now has to give back, meaning fewer or no deaths immediately following the eclipse (Pinxten and Van Dooren, 1992:103). Traditional Cherokee of the Southeast perceive either solar or lunar eclipse as an attack on the sun or moon by a great celestial frog, and would attempt to scare it away with noise (Mooney, 1982 [1900]:257).

In the Arctic, the earliest accounts by non-natives in the area describe the Inuit reacting with considerable apprehension to a solar eclipse (MacDonald, 1998:136–38), although the full import of the event in the indigenous thought systems was not wholly grasped or reported. Such reactions have changed significantly, however, with increased contact and Western education in the area. (Other sun-related phenomena, such as haloes and rainbows, are discussed in chapter 6.)

SOCIOCULTURAL SIGNIFICANCE OF THE SUN

Technical knowledge of the fundamental motion of the sun is basic to fieldwork in ethnoastronomy. But of real interest to ethnoastronomers are the native observations themselves, and the cultural meaning and use made of these observations. The Mescalero Apache in the U.S. Southwest, for example, as observers in the north Temperate Zone, see

the sun rise in the east, climb up through the southern portion of the sky, then descend to the west, and therefore call "sunwise" all circular motion that proceeds from left to right (or "clockwise"). For them, it is the prescribed direction of movement for many ceremonial and even daily activities (Farrer, 1996:70). Likewise, the Plains Crow consider sunwise motion sacred, and use it to pattern their own movement in sacred space: "when one enters a tipi, a sweatlodge, a Sun Dance arbor, or any other sacred structure, one turns to the left and circles to the right" (McCleary, 1997:102), an attitude similar to that of the Lakota, as well (Black Elk in Neihardt, 1979 [1932]).

Certainly it is important for ethnoastronomers to study how non-Western peoples observe the sun, their use of these observations to plan their activities, and any cosmological significance ascribed to the solar entity. But it is also important to leave behind ethnocentric notions of the sun as an orb of intensely hot gases about which we on Earth revolve. Ethnoastronomers should also try to learn who/what the sun is, what meaning it holds for any given people. For the Bororo, the sun, meri, is clearly related to Sun, Meri, a culture "hero" present in much of their folklore. Meri as culture hero is characterized by such traits as strength, cleverness, and the ability to restore life, which he exercises on several occasions to bring his brother, Ari or Moon, back to life after several different mishaps kill him. In these attributes and through the kinship relationship between Sun and Moon, the Bororo are expressing metaphorically their conceptual understanding of the celestial sun and moon. That these cosmic brothers, who are also tricksters, are associated with heat is another, more overt link between the celestial and mythic entities. As described in the Bororo myth that begins this chapter, the pair is literally fanned by the Karawoe up into the sky after one mischievous prank too many: they have become "too hot" to be allowed to stay down on Earth! (Additional comments about the Meri-doge are presented in the next chapter; see Fabian, 1992, especially chapter 6, for more details of the sun and moon among the Bororo).

Trying to depict accurately what the sun is as a celestial body as understood from the Bororo perspective is difficult, especially due to the acculturating influences of their immersion—geographically, if less so socioculturally—within the nation-state of Brazil. Earlier accounts of the Salesians suggest that the Bororo perceived the sun as a shining gold disc that is carried through the sky by the spirits of a particular category of deceased shamans (Colbacchini and Albisetti, 1942:97). Very little was forthcoming from contemporary villagers about traditional concepts of what the sun is, substantiating my call for a living ethnoastronomy to learn what we can of native knowledge and beliefs while it is still there. For the Bororo, the sun is used in village orientation, for day-time reckoning and for planning and carrying out seasonal activities; its movement inspires the direction of social movement as mapped out on the village circle; and as an anthropomorphic culture hero it provides one model for personal character and social interactions (Fabian, 1992; 1994 [1995]).

The Ramkokamekra of the Eastern Timbira, residing only about 5° south of the equator, "regard themselves as primarily dependent on the Sun (Put) and in much lesser degree also on the Moon (Puduvri)" (Nimuendajú, 1946:232; orthography has been simplified). Addressed as either "Father" or "Grandfather," Sun may be supplicated for rain or to protect plants and animals, may be spontaneously addressed in private petition, and is asked to protect a newborn infant. But there seems little technical observing of the sun for calendrical purposes, and as Nimuendajú reported, "They do not ponder the nature of the solar body" (232).

North of the equator in Mesoamerica the Maya continue to observe the sun keenly, as did their Classic ancestors a millenium and a half ago. In the pre-Conquest Quiché Maya text, *Popol Vuh*, the culture hero Hunahpu with his brother Xbalanque, defeat the Lords of Death and the Underworld and ascend into the sky, where "the sun belongs to one and the moon to the other [respectively]" (D. Tedlock, 1996:141). Today, B. Tedlock reports that the Maya "describe the sun as a human or god-like figure with a brilliant round face, who rises each day on the eastern horizon and faces his universe with north on his right hand and south on his left hand" (1992:178). As was true in Classic times, the Maya today still observe the sun for calendrical and agricultural purposes, in combination with other astronomical observations.

In the U.S. Southwest among the Navajo, Sun is perceived as a deity of great power who together with their "most beloved deity," Changing Woman, procreate the Hero Twins, who were important in making the land habitable for humans by slaying monsters (Griffin-Pierce, 1992:30; Oswalt and Neely, 1999:341). But Sun, Jóhonaa'éí, is also a disk carried by He-Who-Returns-Carrying-One-Turquoise. While monthly and nocturnal time is marked by the moon, "The sun's movement along the horizon is responsible for the seasons" (Griffin-Pierce, 1992:74–75). Among the Puebloan neighbors of the Navajo the sun is described as "the most powerful deity in their large pantheon of gods" (Williamson, 1984:59), and is a dominant force in their lives. As such it is offered sacred cornmeal and prayer. In Hopi towns sun priests or watchers make use of detailed horizon observations for a solar calendar used to determine planting times and times for major ceremonies, clearly continuing an ages-old practice in the region encoded in ancient architecture, rock art, and folklore (Williamson 1984:ch. 5).

For the Cherokee of the Southeast the primordial sun was too hot, so conjurors raised the sky arch to be seven hand-breadths high so that the sun would be far enough to not burn everything (Mooney, 1982 [1900]:239). Mythically, Sun and Moon are described as sister and

brother, respectively, who have an incestuous relationship (256–57), but the gender of the two is not always consistent in Cherokee lore (cf. 440, n. 7). The sun, called differently by commoners and priests, is also known as Unelanuh'hi, "the Great Apportioner" (259), indicating a significance derived from solar observation of order and organization.

Scant information can be found on concepts about or observations of the sun for far southern peoples. The Ona of Tierra del Fuego consider the male sun husband to the moon (Cooper, 1946:124), while further north in the southern temperate region of the Gran Chaco, Sun is commonly a woman and Moon a man, unless the two are male twins, when their relationship of stronger-weaker brothers is common and similar to that perceived by the Bororo (Métraux, 1946:366).

In the far north Yukon Territory the Kutchin observe sun and moon for weather prediction (detailed more in chapter 6), but Osgood (1936), who reports on the Kutchin in detail provides little other mention of sun or moon. Most commonly among the Arctic Inuit the sun and moon are considered to be sister and brother, respectively. Once human, they rise into the sky following brother Moon's incestuous advances on sister Sun. As she flees carrying burning moss, he pursues with the same burning material that eventually goes out; their chase carries them into the sky realm. The story is recounted in a myth that MacDonald (1998) describes as "one of the most widespread and complex of all Inuit traditions," an epic story "addressing universal concerns about creation, social and cosmic order, nourishment, retribution, and renewal" (97).

Clearly, the sun stands out as an entity of major proportions in much native astronomy, cosmology, and folklore. Recognized for its powerful presence and regular motion, it has been from the native perspective a force by and with which to reckon.

EXERCISES: SOLAR OBSERVATIONS

WARNING: NEVER LOOK DIRECTLY AT THE SUN! Doing so especially once the sun is above the filtering effects of the thicker atmosphere on the horizon can cause serious eye damage.

Exercise 2.1 Gnomons and shadow-casting

Needed: a straight stick or rod, some smaller objects as markers, and a tape measure; a flat unobstructed space, and sunny weather.

Objectives: to determine true north (and/or south), to get a sense of the sun's movement over time, and possibly to record a northern and/ or southern extreme for the rising and/or setting sun.

A ***gnomon*** can be any device used to cast a shadow. We are interested in how a gnomon can be used to tell time and directionality.

Find a relatively flat space free of obstructing and shadow-casting features, such as a hill-top, field, courtyard, or even a flat roof. (Ideally, your chosen site can remain undisturbed for several weeks.) Stand your stick or rod, now a gnomon, in the center of your chosen space. On one day, try to establish actual noon, and true north, by measuring the length of the shadow at least once every five minutes as you approach the clock-time of noon.

How will you know when it is noon? What direction does the shadow mark at noon?

Record your findings (date, time, length of shadow) and mark the length of the noon line. Repeat this procedure on at least one other day and compare your results. (If you are on a semester schedule, try doing it twice each month.) What can you say about the sun at noon from your findings? If possible, try this every day for two weeks, one week on each side of the official solstice and/or equinox, and record your findings. Does the sun really "stand still" at the solstice? How does this contrast with its movement at the equinox?

If your space allows, use your gnomon to indicate the direction of sunrise and sunset, and compare this with sunrise/sunset measurements taken on other days. Report on your observations of the movement of the shadow.

Exercise 2.2 Marking sunrise and sunset

Needed: A flat space with unobstructed view of the horizon, and at least two sticks with smaller markers optional.

Objectives: To mark the sun's movement on the horizon.

Since looking at the orb of the sun is extremely hazardous to your eyes, wear sunglasses and try to catch the sun's first gleam on rising, and its last gleam as it sets. (Do NOT stare at the sun!) Pick a spot from which you can observe the horizon (even better if you have a view of both horizons from the same spot). Be sure to mark this space as the center of your "observatory." If you can work with a partner, have him/her hold one stick as a fore sight while you look over a stick placed at the center (this becomes the back sight). Have your partner place his/her stick vertically right where you see the gleam of the rising or setting sun. If you are working alone, use a stick at arm's length, and another just in front of you. Record the date and time. Once the line is fixed in place, take note of any distinguishing horizon features at the rise or set point, and record all of this. Make additional observations as frequently as practical, remembering to make each observation from your fixed "observatory" center point. Measure the distances between the markers established on different dates (sticks can be removed and replaced with smaller markers if desired). Analyze your data; what can you say about the movement of the sun as seen on the horizon? If possible, do exercise 2.2 for two weeks on either side of a solstice or equinox, and compare that with observations made at other times.

Endnote

[1] From Colbacchini and Albisetti, 1942:237–38; an English version is included in Wilbert and Simoneau, 1983:43–44.