

INTERPRETING THE SKY

Von Del Chamberlain

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by

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National Air and Space Museum

Smithsonian Institution

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"Two things  
fill my mind with ever new and ever greater  
wonder and reverence, the oftener and the longer  
I allow my mind to dwell on them--  
The starry heavens above and the moral law within me."

Kant.

.....

SKY INTERPRETATION is the art in process of coupling direct observation with skilled communication for the purpose of informing people about the sky, its objects and phenomena, with special emphasis upon relationships of these to Earth and its occupants.

This paper is intended to introduce you to a realm of natural interpretation which has been generally neglected in interpretative work. It will not be possible here to give detailed instruction about sky phenomena, but only to start you thinking about the importance of the sky in natural history interpretation and to make you aware of some useful procedures and materials. Suggestions will be offered which, if followed will start you on your way to become an effective sky interpreter,

adding to your comprehensive ability as a naturalist. You will find a study guide and selected reference at the end of the paper. These will guide you in your study of selected sources of up-to-date information needed to become knowledgeable of the sky and its extremely interesting objects and events.

I. WHY INTERPRET THE SKY?

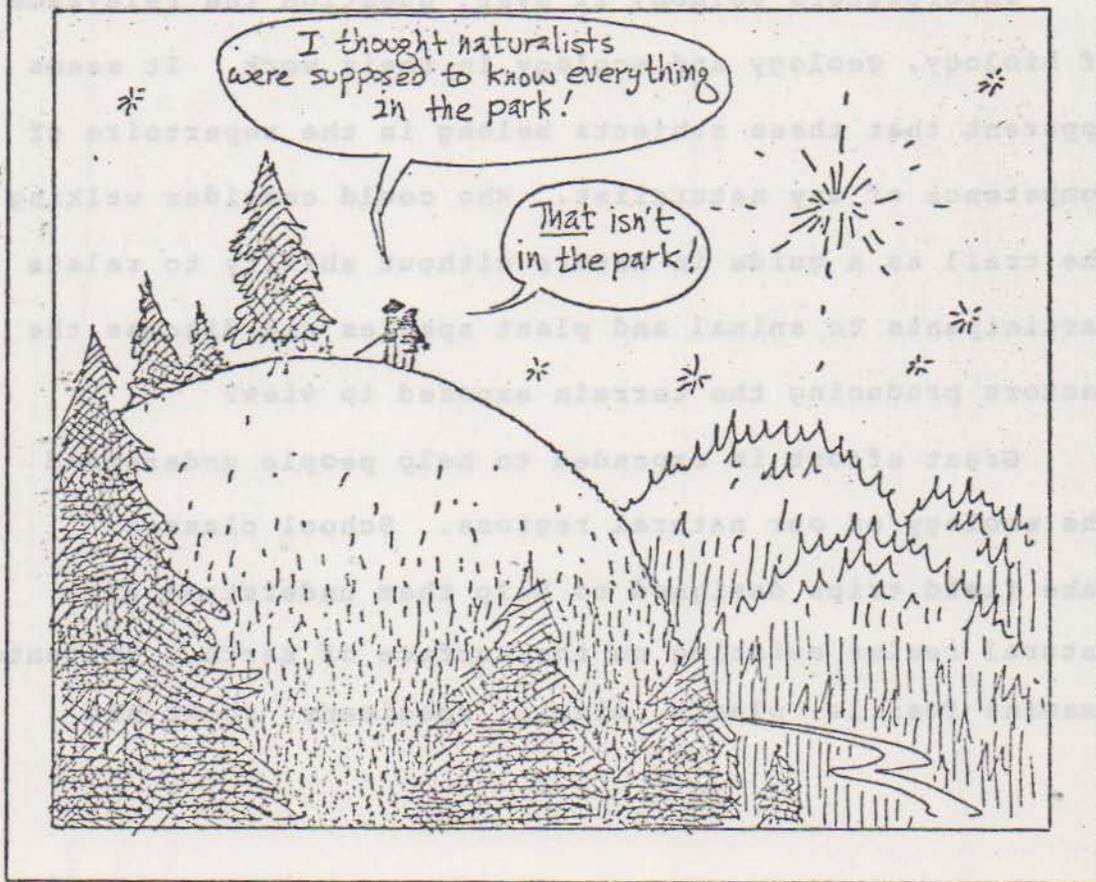
"To a person uninstructed in natural history, his country or seaside stroll is a walk through a gallery filled with wonderful works of art, nine-tenths of which have their faces turned to the wall."

Thomas Henry Huxley

. . . . .

Interpreters seldom, if ever, question the relevance of biology, geology and ecology in their work. It seems apparent that these subjects belong in the repertoire of competence of any naturalist. Who could consider walking the trail as a guide in nature without ability to relate participants to animal and plant species and discuss the factors producing the terrain exposed to view?

Great effort is expended to help people understand the ecology of our natural regions. School classes take field trips designed to help them understand the natural realms existing on the surface of Earth. Students examine fossils, plants, mineral specimens, rocks and



soil. They thrill at the sight of various animal species in the natural habitat and wonder as they view the demise of animal and plant decaying back into the environment.

But why sky interpretation? Most objects of the sky seem removed from everyday life; so unimportant compared to other things. Who can touch a star and why should we care about the moon and planets? What difference do they make in our lives? Does interpretation of the sky really belong in the list of abilities and duties of those who teach in the out-of-doors?

Let us briefly consider and list seven reasons why sky interpretation is both appropriate and important for campfire programs, and conducted walks.

1. The sky is part of the scene

The cartoon in figure 1 is one of the oldest of humor used at campfire gatherings, but illustrates an important point. What is the vertical boundary of the landscape? Does it end at the tree tops or mountain tops? Would anyone wish to eliminate sunlight and starlight from its panoramic splendors? Contemplate the beauty of landscape features against clear, blue sky as one enjoys the penetrating warmth of sunlight. Consider the stirring of the intellect as skylight fades, the air chills slightly

and the stars come out. Pause to contrast our current concepts with those we might have if we lived on the surface of a perpetually clouded planet.

Consider the impressive panorama of events which take place in the sky. This is not a static, eternal, unchanging part of the environment. Rather it resembles a hemispherical stage on which we, the audience, glimpse images of great significance. The stage is decorated with a background of points of light we call stars and on this background the sun, moon and planets play out their respective parts. Occasionally the scene is torn asunder by the blast of a brilliant fireball as a meteorite body plunges into the atmosphere, dropping its fragments into the audience. Or, more frequently, it is split by bursts of lightning, followed by the blast of thunder. Stage lighting can be as soft and gentle as the aurora, shimmering its rays and curtains of soft colors across the northern or southern polar sky. Sky events continue and audiences come and go, pondering the significance of what they see and interpreting the meaning of the drama.

No, the sky is not outside the park!

It is one of the special features that can best be studied and enjoyed in our natural areas.

2. The best conditions for enjoyment of the sky exist in natural areas.

Now consider the average visitors to a supervised natural area. Their long-planned expedition into nature probably starts in the tremoring city with its grey sky and ear splitting, bustling activities. It might end in the deafening silence of the quiet valley where sky vision extends millions of light years and they can, in essence, touch both the past and the future while standing in one place. To be introduced to its wonders by the skilled assistance of an interpreter is an unforgettable experience.

3. The contrast between city and country sky should be clearly realized.

The conditions existing in protected natural areas are becoming more and more special as population grows and the associated problems increase in magnitude and complexity. One of the most apparent of these problems is the quality of the sky. Older people now residing in the city can be overheard to say, "I had forgotten what the Milky Way looked like. It has been ten years since I have seen it." Younger ones, who have grown up in metropolitan areas are astounded as they gaze, almost

in disbelief, at the star-flecked sky. One young man commented following a sky interpretation activity at a national monument, "I've found a whole new world to explore. I had no idea it existed as I see it here." It is sad to realize that many people live out their entire lives without ever seeing the star-lit sky from the country on a clear, dark night.

The clarity of the sky away from city lights combined with the freshness of the clean air, the majesty of rocks and trees, and the mystery of creeping, bounding and flying creatures produce the feelings which so many people crave and go to such great expense in time and resources to experience. The sky should not be neglected in helping people more fully reap the rewards of their efforts. Indeed, people must be clearly aware of environmental factors illustrated by the deteriorating transparency of the atmosphere.

4. The earth developed over a very long period of time through physical processes operating on material in space.

Next, consider our growing awareness that the origin of the natural surface of our planet is to be understood as we look out in space. Perhaps one of the most important

of the environmental messages from astronomy is the realization of the time scale and the physical processes going on in space to produce worlds like our own. By looking out in space with telescopes and making use of the discoveries of physicists and astronomers we can begin to comprehend the fantastic transition which slowly occurred over billions of years of time, starting with dust floating between the stars and continuing to our present sun and earth with mountain slopes bedecked with pigment of flowers and trails walked by emotionally motivated humans. What a marvelous transition to attempt to understand! Today we can look into the sky and see evidences that the processes of "creation" are still going on around us as the universe continues to evolve.

5. The earth is an extremely small part of the vast universe.

One more argument for including the sky in interpretative programs is the simple fact that most of the environment of man is out in space. Actually the entire solar system, which seems so vast to us, is like an impurity in the known universe. The earth, orbiting the sun, has been appropriately referred to as a "spaceship," complete with its controlled conditions, sustaining its occupants as it drives through space.

We are so immersed within our immediate surroundings on the surface of our tiny planet, orbiting one star, that we are prone to forget that nearly all of the universe lies out there. Review the words of Henry Huxley at the beginning of this section and apply them to the realm of the stars. Unless one is acquainted with the starry sky, he really has no concept of the world at all; he is walking this planet blindly, completely ignorant of most of the universe which he is capable of perceiving.

6. Life support conditions result from astronomical relationships.

Perhaps we can better understand the magnitude and importance of the problems of preserving the conditions on the limited thin surface of Earth by knowing the factors which produced and sustain these conditions and contrasting them with the empty harshness beyond the protective atmosphere.

As we look out into the night sky we see the stars.

What is the significance of a star? To answer consider the importance of the most apparent star in the sky.

The energy generated deep in its multi-million degree core makes its way to the surface of the star and then leaps through space. A tiny percentage of this energy falls upon the little planet Earth, warming the atmosphere.

Among our choicest blessings we must include the existence of sunlight and no pleasure is more worthy of our respect than that of warmth of sun upon the skin.

Yes, the sun is just one of the many stars known to exist in the universe, but it gives us warmth, food and sustains the Earth and other planets in their orbits, guiding us through regions flooded with enough but not too much radiant energy. By realizing its complete domination of our lives and then looking into the night, seeing thousands of other stars, we become aware that numerous other planetary systems might exist in space. The other stars, like the sun, are sources of energy. They too may have their planets, perhaps even thriving with intelligence. Indeed, scientists estimate that there may be millions of other planets similar to Earth within our own Milky Way galaxy. Realizing this possibility makes the stars seem more significant.

Modern astrophysics gives us even greater perspective of our own existence. Evidence suggests that the very elements composing our physical bodies were actually manufactured in the centers of the stars through nuclear fusion processes. If people are directed to contemplate such possibilities while looking into the starry sky,

they will see more than mere specks of light and they should appreciate the miracle of their own existence more than they possibly could without interpretation of the sky.

7. Sky interpretation helps people comprehend themselves on the Earth in the universe.

Following a sky interpretative program people often comment that they feel so insignificant, looking into the starry night. Such comments are, perhaps, the most powerful reasons of all for interpreting the sky. The most important human quality, after all, is the ability to reason: to perceive stimuli, transpose them into mental impressions which are stored, sorted, retrieved; to formulate questions and answers. Only by the understanding which results from reasoning can one look into space and feel insignificant. This may be the most important type of human experience. An effective sky interpreter can assist people in benefiting from such experiences.

Summary

There is much more to argue for the importance of sky interpretative programs. Too much more to include in this introduction. Perhaps this is enough to whet your appetite for becoming an interpreter of the sky.

Before going on, let us briefly review the highlights of what we have considered. We live on a planet, a natural spaceship, orbiting one star which makes life possible. The earth, other planets and their satellites, other bodies of the solar system, and the sun were derived from organization of material which was previously floating in space. This required many billions of years. Our comprehension of our planet is significantly stimulated by careful study of both the day and night sky.

And here we are, standing under the stars, looking outward, wanting to comprehend ourselves existing in the universe. Are not the very best human qualities illustrated in this experience?

Where can this inquiry into the earth and the universe be better done than in natural areas, removed from city lights and smog, amid the surroundings which are so conducive to learning.

And who can do it better than those involved in interpretation? Probably no other group of people have a better combination of skills, interests and opportunities to inform the general public about the sky and space than interpretative specialists and other

who teach in the out-of-doors.

It is hoped they will now agree that environmental interpretation is incomplete without the upward dimension.

.....  
"If the stars should appear one night in a thousand years, how would men believe and adore, and preserve for many generations the remembrance of the city of God."

Emerson

## II. SUGGESTED PROCEDURES FOR SKY INTERPRETATION.

"Astronomy compels the soul to look upwards and leads us from this world to another."

Plato  
 . . . . .

### Getting Started

How does one gain the ability to interpret the sky?

Is it necessary to have one or more college courses in astronomy? Must one have special instruction in sky interpretation to be qualified to instruct others about the splendors of the sky? This would certainly help and one should take advantage of them if such courses are available. Certainly one should not play the part of the expert without the authority derived from knowledge acquired through long and diligent study. However, it is also a mistake to use the excuse of insufficient knowledge and deny people the opportunity of experiencing the intellectual stimulation of a clear and beautiful night sky. Adjust your method of presentation and learn as you go along rather than avoiding the subject. You can learn the basics quickly and occasionally visitors will be a source of information.

Study the sky be careful and frequent observation. Contemplate the notions ancient people must have had as they pondered the objects and events of the sky.

Note the questions which come to mind as you try to mentally change your reference in space and time and peer through ancient eyes. Then go to books which represent attempts of astronomy interpreters to sort, select and present their most important thoughts and explanations. Seek out the latest versions of our models of the universe and try to see how these have ripened from the same trees which nurtured earlier notions.

Capture the thrill of the sky yourself and share your discoveries with your clients, being cautious not to claim abilities and offer explanations not yet clear in your own mind. Start with simple and brief samples of what the sky has to offer.

Suppose, for example, that you have learned to identify a few of the bright stars of the current night sky and have learned a few facts about them. Suppose further that you have arrived at the campfire prepared to present the regular program which you have presented many times before. The night is clear and a thin crescent moon sets as the twilight dissolves into a dark, crisp night with sharp, gleaming stars. Present your program as planned. As you conclude you should be at your best; completely confident and relaxed in the enjoyment

of having stimulated the awareness of your audience about some aspect of natural history.

Having done all this don't be guilty of letting your audience go without even drawing their attention to the "magic" of the sky. You might add a postscript essentially as follows:

"No where else can you experience exactly the same collection of items and events that you see around you in this particular place. You have heard what you came to hear and seen what you were promised this evening, but I want to call your attention to one more special feature of this place. Notice how the familiar surroundings on the landscape have melted away to become silhouettes, dark against the slightly brightened sky. And look at the stars! How long has it been since you last saw such a sky? Or have you ever seen such beauty before? Just think of what you are seeing. Consider the vast distances you can see as you look off there into deep space. What questions come to your minds? Let me hasten to say that I am not an astronomer and do not claim to be able to answer the questions you might like to ask, but I would enjoy spending a few minutes speculating with you. It might be interesting if we just asked the questions; even if we can find no definite answers to any of them.

I have learned to recognize a few of the brighter stars and can tell you some things about them. I know a few Indian legends about the stars. Now I am going to walk over into that meadow and spend a few minutes reviewing the stars I know. You are invited to tag along. I am sure we can learn a few things together, share a few ideas, and become aware of things neither of us have ever noticed before."

In this way you will have clearly stated you are not an "expert" in astronomy, but you have done it in a very positive way. People will recognize that they will be rewarded by what you offer and you will probably not lose many from the audience except those who reluctantly carry sleeping babies back to camp. Those who go with you will probably never forget their brief introduction to a realm of nature in which they have previously felt little personal involvement, and you will have acquired experience and confidence in beginning to interpret the sky. From the questions asked you will recognize the things you must learn in order to do a better job. You will acquire additional interest in the sky yourself and next time you will be able to go a little further with more confidence.

After a few such experiences, it is suggested that you begin to blend sky interpretation into your programs. Think of opportunities to relate objects of the sky to subjects included in the programs. Such relationships are more numerous than you might at first think. Just being alert to the possibility of such relationships will help you discover them as you continue your study and your work.

For example, you can always have fun on a dark and clear night by raising the question of the possible frequency of planets somewhat similar to earth revolving about stars out there. What variation of intelligent creatures might exist and how many others have experienced similar problems to those which are with us now? How many eyes out there are turned in our direction at this very moment, speculating upon the question, "Are we alone in the universe?" Even though you don't supply many (if any) direct answers to such questions, this will provide a very stimulating way of reviewing environmental factors which make our existence possible and of the need to thoroughly understand these factors and control our interactions with other elements of the eco-system.

In summary start by learning about the sky, using selected bits of newly acquired knowledge in your work, applying all you know about effective interpretation. Steadily work toward the time when you can prepare and present special programs about the sky. Plan the best sky program you can conceive of and try out portions of it by weaving them into your tried and proven programs. Then, when you are ready, present your first complete program of sky interpretation.

"The most beautiful thing we can experience is the mysterious. It is the source of all true art and science."

Albert Einstein

The World's Finest Sky Theater

Man: The beholder and expounder of heaven.

Posidonius (135-51 B.C.)

The outdoor amphitheater offers a fine opportunity to communicate information and concepts about the sky. Planetarium educators who work in sky simulation theaters, can only imitate the setting available to the naturalist in outdoor theaters. A planetarium is a grand classroom of the sky, but its limitation is apparent. Occasionally a visitor enters a planetarium, sometimes even on a cloudy night, watches the program and then seeks out the lecturer to inquire, "How were you able to make the ceiling disappear so that we could see the stars?" With these few exceptions, everyone recognizes the artificial nature of the planetarium sky. There is a distinct difference in the response of an audience to a good planetarium program and an equally good program presented under nature's stars. The one is make believe - the other is real.

In the outdoor amphitheater the interpreter can use slide and motion picture projection to bring meaning to the panorama of objects and events portrayed overhead on a clear dark night. It is important to note that an illustrated amphitheater sky program more nearly resembles a conducted walk than it does other amphitheater programs. In the regular amphitheater interpreters use pictures to discuss features of the region. But in the sky interpretative program the natural objects of interest are viewed directly and interpreted just as they are on a trail walk. This, indeed, is the very special feature of the night sky interpretative program, which makes it so memorable to people, especially to those who experience it for the first time. Most people have seldom, if ever, experienced the thrill of tutored contemplation of the universe as they look out and see some of its features.

Another advantage of this approach to sky interpretation is that amphitheaters can hold several hundred people. This allows the interpreter to handle larger audiences than he can accommodate on trail walks and other activities where he interpretes the objects of nature directly. Naturalists should consider this

advantage in planning other amphitheater programs. Why not use amphitheaters more frequently during daylight hours, interpreting the natural surroundings which can be studied from that one location?

The illustrated sky program can take any direction the interpreter desires, ranging from simple identification of stars and planets to programs which identify objects of the sky in context with carefully selected information about them and their relationships to the more immediate environment. The importance of relating the sky to people and objects, here and now, cannot be over emphasized. The relationships are not apparent to most people. They must be carefully studied by the naturalist and clearly pointed out to audiences.

The screen can be used to project photographs of star groups to assist people in identifying and becoming familiar with sky objects. In addition it can be used to extend a person's vision beyond the ability of the naked eye by projecting photographs made with large telescopes. It is more exciting for people to learn about objects in deep space when they know approximately where they are located and can glance in that direction as they learn. Several of the most intriguing deep sky objects can faintly be seen with the naked eye.

What a thrill it is to be able to look out and barely see such an object, then glance down to the screen and see the same object with the brilliance and detail revealed by one of the world's great telescopes. The experience is completed by providing the opportunity, after the program, for individuals to use a small telescope (or even binoculars) to view selected objects discussed in the program.

#### The Campfire Circle Sky Program

The basic difference between a campfire circle and an amphitheater is that the former lacks a projection screen. This is not necessarily an undesirable limitation. Indeed, a skillfully given campfire program can be a most entertaining and stimulating event. The audience is usually smaller than in many amphitheaters. This and other factors provide the setting for an informal, provocative, interpreter-to-visitor experience.

The interpreter must use his most important abilities: to select meaningful and interesting subject matter; to sequence ideas in an exciting way; to present information in the most stimulating manner possible, using voice and visible stimuli to communicate ideas to every individual in the group.

A sky interpretative program at a campfire might begin just as the stars are becoming visible. It is often effective to begin with a legend about the stars. If possible use a story from the lore of primitive groups once occupying the region. American Indian mythology, for example, abounds in sky legends as does the lore of all primitive cultures. What better way can you imagine to start a program than to relate a story which might have been told to a different audience at that very place hundreds or thousands of years ago.

Be sure that a few important visible objects are clearly identified so that every member of the audience with vision can locate them. A powerful flashlight beam works well as a pointer if the audience is small and the sky is dark. Reference to distant landscape features is another method of identifying sky objects.

The program might end when it is dark enough to see fainter sky features such as the Milky Way and the Andromeda Galaxy. People should depart from such a program with the ability to locate and identify several objects and features of the sky and relate information about each which bears some significant relation to the surrounding geographical region and/or to themselves.

Take the Milky Way for example. People should leave being able to identify the detailed structure which can be seen under excellent viewing conditions and knowing that the Milky Way is not even visible in places with low quality viewing conditions. They should be aware that the Milky Way is the rim of our Galaxy seen from inside and that they constantly move with the earth as it orbits the nucleus of the Galaxy, completing one revolution in about two hundred million years.

Perhaps the best indication of the success of the program is the number of trees bumped into and stones, roots and logs stumbled over by members of the audience as they return to their camps with their senses still turned to the sky.

#### The Evening Stroll and the Sky Walk

.....

One by one  
The stars are lighted by the sun  
Before he retires to his lodge for rest.  
It is his last duty of the day.

Otoe song about stars

.....

The evening stroll can be one of the most enjoyable interpretative activities. Perhaps the most important reason to consider conducting evening strolls is to help people sharpen their senses, becoming aware of subtle changes

in and relationships between various elements of the environment and expanding their concepts of the natural realm.

The program should be announced at times and places where people will become aware of it. It is usually advisable to require registration prior to the walk and limit the size of the group as appropriate for the location and other conditions. This also provides an easy way to distribute information about: (1) type of clothing suggested; (2) insect repellent (if needed); (3) flashlights; (4) time and place of departure; (5) duration and distance; (6) objectives of the activity; (7) weather and other factors which may lead to cancellation or modification of the activity.

Ideally the program should begin just before sunset while one can still see the day - star supplying our life preserving energy. Beginning this early is difficult since it lengthens the activity considerably. In mountainous regions it may be very impractical since the sun may set behind mountains in the late afternoon several hours prior to darkness. One must decide upon the beginning time and place considering local conditions,

length of twilight, schedules, objectives of the program, and other factors.

For purposes of illustration we will describe a program taking place where the period of time between sunset and darkness is not extended by a high, mountainous horizon. The following briefly describes such an evening's activity.

Participants meet at the appointed time and place on a clear moonless evening. It is a carefully selected place which takes advantage of the beauty of the region. People gather as the sun approaches the visible horizon. The interpreter calls attention to the sun, reminding the group of its tremendous significance and explaining factors of earth-sun relationships which are most pertinent to that latitude, altitude, time of year, etc. He or she encourages the visitor to notice subtle relationships as well as those which are so apparent that they tend to be ignored.

Members of the group watch, listen and comment as the earth turns them away from the direct rays of the sun. The sky and surrounding terrestrial features change color as the blue rays are scattered and the last yellow and red hues bathe the landscape. It is

difficult to mourn the passing of the sun each day since it goes in such splendor and allows our vision to penetrate to such great depths in space and time.

The stroll begins along a carefully chosen path. Plants and animals may provide special interest. Frequent stops are made to draw attention to the rapidly coming night. Differences in color, brilliance and apparent form of landscape features are appropriate subjects for interpretation. Attention is drawn to the varying brightness of the sky in different directions around the horizon. The earth's shadow may be visible as a slightly violet-gray region above the horizon opposite where the sun has set.

The coming of night is a majestic and beautiful occurrence to behold. This is especially true when it is experienced in a remote and scenic region. Changes occur rapidly and the interpreter works hard to awake the sensitivity of his group to the continuum of changes.

Somewhere along the trail, at an appropriate place and time, the party pauses quietly for a minute or so to carefully listen to the sounds of evening; the breeze rustling leaves, twittering birds, and the many other sounds accompanying nightfall on our lively

planet. A reward, such as a free star map, is offered the first person in the group to see a star or planet. When it is dark enough to see the brighter stars, they are identified. This is the easiest way to begin to learn to recognize them. Watching as it gets darker, people first see only the brightest stars and then notice greater and greater detail around them as fainter features become visible in the darker sky. At the end they can still recognize the most prominent stars, now couched in groups of varying brightness and hue, and relate groups of stars to each other in order to establish mental patterns which will last.

So sky feature recognition begins as soon as the first are visible and continues through the walk with considerable repetition and addition of greater and greater detail.

The climax of the activity has been planned for a location with outstanding sky visibility. This place is reached when it is dark enough to see many stars (2nd and 3rd magnitude). This is the main stop for sky interpretation. At this place the interpreter skillfully relates an American Indian sky legend (or other legend appropriate for the locale). This is especially appropriate in a natural setting since it reminds people of concepts from antiquity when humans

lived as more intimate counterparts of nature. The contrast is established between ancient concepts of the sky as an enclosed dome and our current realization that the sky opens toward infinity. The interpreter employs various comparisons to impart knowledge about distances, sizes, and separations of objects in space. Arcturus, a relatively nearby star, is identified. The naturalist asks if anyone in the group is willing to admit to an age of forty years. He/she explains that the light now entering the eyes, stimulating awareness of Arcturus, left the star about the time of the birth of the forty year old person.

The star Antares is identified with the comment that if this star could be placed where the sun is, leaving other objects of the solar system as they are, we would be inside the star!

A sun-like star, such as Eta Cassiopeia, is identified and its distance is indicated. The possibility is raised that this star might be orbited by an earth-like planet with people-like creatures on it. Noting the time required for radio waves, which travel at the speed of light, to journey between here and there, the group speculates about the radio and T.V. programs

that culture might be receiving from earth.

Interpretation relating sky and earth continues as long as is practical. The significance of the night stars is discussed, pointing out that they are energy sources like the sun and that they are the likely element-producing factories of the universe. People are reminded of the necessity of these elements for the existence of the mineral and biological kingdoms. Everyone is made to feel the relationship of the stars to the "miracle" of the moment of our existence.

The interpreter is selective and brief and encourages discussion, skillfully directing questions and comments toward the ideas he wishes to introduce. The group stays awhile - deliberates together - and then starts on the return trail.

One more stop is made near the end of the walk. Now it is dark enough to see such features as the Milky Way, clusters of stars and nebulae (unless the moon is bright). The interpreter helps people appreciate the details which can be seen by eye coupled with inquiring mind. A very distant feature, such as the galaxy in Andromeda (or the Magellanic Clouds in the southern hemisphere), is pointed out. They are made to

realize the geological changes which have occurred since the light they see it by started from the object.

Participants are reminded of the extremely specialized nature of the surface of our planet, a condition produced in the universe by operation of natural processes over billions of years of time. These same processes still continue to go on in space and most likely produce other planetary systems. The group is asked to consider the possible number of other planets with intelligent life out there and to imagine the possible number of other inquiring eyes and minds peering outward at this very moment.

The group walks on to the termination point. People are thanked for their participation and encouraged to continue interest in earth and sky and to participate in other interpretative activities wherever they go. The interpreter bids his companions for the evening "good night."

Note that a telescope available at the termination point offers an excellent second feature for those who wish to stay longer and see in greater detail.

. . . . .  
 "To see the earth as it truly is, small and blue and beautiful in that eternal silence where it floats, is to see ourselves as riders on the earth together, brothers on that bright loveliness in the eternal cold--brothers who know now they are truly brothers."

Archibald MacLeish - Dec. 25, 1968  
 Written as humans first orbited the moon

The sky walk is a special variation of the evening stroll. The walk is taken on a trail which rises significantly in altitude. It need not be a long walk, but must be a climb upward "into the sky."

The trail is chosen to allow the stops described in the evening stroll. It should overlook the surrounding region, which will be interpreted, and should culminate at an open area when 2nd magnitude stars are easily visible.

At the top the interpreter might well recite an appropriate legend involving climbing into the sky (several American Indian legends are of this type\*).

The most important distinction between the sky walk and the evening stroll is the use made of the fact that the group has "climbed a little way into the sky." The major sky interpretation should take place at the top of the trail. Then the group carefully works back down the trail with a final stop at the bottom to look at the Milky Way and other faint features before terminating the activity.

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\*For example: Indian Legends of the Pacific Northwest, Ella E. Clark, University of California Press, 1953, "The Big Dipper and the Milky Way," pp. 152-155.

The Prairie is dark  
 But across the sky  
 Is a trail of light.  
 It is the ghost pathway  
 Of the departed warriors.

Otoe song of the Milky Way  
 . . . . .

### III. SKY PHOTOGRAPHY WITH THE STATIONARY CAMERA

Color photographs (slides) are among the most effective aids for sky interpretation. Cameras with "fast" lenses combined with high speed color photographic films make it possible to obtain high quality night sky pictures with a stationary camera. Color slides of star patterns show essentially what the eye sees and, when used effectively, greatly simplify identification of sky features.

The following equipment is desirable for obtaining constellation and other night sky pictures.

1. A camera with f 1.2, f 1.4, f 1.8, or f 2.0 lens and with "time" or "bulb" setting to permit long exposures.
2. A sturdy tripod.
3. Color film rated at ASA 160 or greater.
  - a. Kodak High Speed Ektachrome - ASA 160. Can be developed at ASA 400 or faster with extra processing cost at Kodak processing centers and many photography shops.
  - b. Ansco GAF 500 - ASA 500. Can be developed at ASA 1,000.
4. Cable release.

The exact photographic procedures depend upon the light conditions and the type of picture desired. A little experience combined with keeping records of the conditions, film used, and camera settings will give you general knowledge of the factors which result in outstanding pictures. The following information will get you started and is given for film rated at either ASA 400 or 500.

#### Constellation Photography

After loading the camera with the appropriate film place it securely on the tripod. Set the camera shutter for a time exposure (time or bulb). Focus to infinity. Open the lens to  $f\ 1.4$ ,  $f\ 1.8$  or  $f\ 2.0$ . The greater the aperture, the more stars you will pick up in a given exposure time. However, you will get some distortion (coma) of the star images at the edges of the field when using small  $f$ -numbers. This is especially noticeable when a bright star or planet is at the edge of the field.

Direct the camera toward the desired group and open the shutter using the cable release. Count off (or use a timer) the appropriate number of seconds, and close the shutter.

The length of exposure time depends upon sky lighting conditions and the range of star brightness

you desire to obtain in the photograph. The limitation for a 50mm lens is about 45 seconds. Longer exposures produce star trailing due to rotation of the earth. The best all around exposure time for pictures taken in the dark of night (after twilight has ended) is 30 seconds. Expose for less time to show fewer stars and more time to pick up fainter ones. An exposure of 30 seconds at f 1.4 will show more stars than the eye can see.

#### Earth and Sky Photography

A very impressive and useful type of picture is one which shows the starry heavens with landscape features in the foreground. Three techniques, each with different qualities, may be used to obtain this type of picture.

- (1) Start photography in the evening just as the stars become visible. The sky is still bright enough from lingering twilight to silhouette landscape features against the starry sky. Try exposures ranging from one second to 15 seconds. As it gets darker, lengthen the exposure range until twilight is over when optimum exposure time is 30 seconds.
- (2) Make use of moonlight to light landscape features. From first quarter (half-full) to last quarter moon there will be sufficient natural light, when the moon is in the sky, to record moon-lit landscape features with stars above. Try a range of exposures up to 30 seconds at f 1.4 to f 2.0.

- (3) Use a strobe light to illuminate selected landscape features. This technique will yield nearly any type of desired lighting of trees and other landscape features in the immediate neighborhood. Considerable experience is needed to obtain exactly the desired lighting.

Earth and sky pictures can be useful, stimulating and even breathtaking in their beauty. A live or dead tree, rock pinnacles, the human figure or other features silhouetted against the star studded sky illustrate man, his world and the immense universe in a striking way.

#### Star Trails

Both artistic and illustrative pictures can be made by taking advantage of the earth's rotation. The camera attached to a tripod on the earth's surface will move with the earth as an exposure is being made. If the shutter is kept open longer than 30-45 seconds, star trailing will begin to be noticed. Stop the shutter down and leave it open longer to purposely draw light trails on the film. Try f 2.8 for 20 minute exposures and f 5.6 for exposures up to two hours. Stopping down beyond f 8 will eliminate most of the stars (all except the brightest ones).

If the camera is directed toward the north star and exposed for several minutes, the star trails will be circular arcs. If directed to the east or west, the

trails will be nearly straight with some curvature noticed on either side of directly east or west. If directed toward the south, arcs will again be apparent, but this time they will be over the horizon since the south celestial pole is below the horizon.

Short exposures preceding or following longer ones on the same frame are especially interesting. For example, suppose one wants to show the rising of Orion. Start the exposure as Orion comes over the horizon and continue exposing as these stars move upward in the field of view. Before Orion passes out of the camera view, stop the exposure (by capping the lens) for five or ten minutes, then expose again for 30 seconds. The resulting picture will show trails for each star in Orion ending with Orion in point outline.

Star trail pictures are very useful for illustrating the earth's rotation. If one describes how the picture is made, people should understand how the sky appears to move as the earth rotates. The pictures are also very colorful since each trail of light will show the color of the star which made it.

#### Use of Sky Photography

Sky transparencies are useful both indoors and outdoors. Slides of star groups projected on an out-

door screen, with clear night sky overhead, can be very helpful in identifying sky features. Begin by describing the direction and appearance of the star group of interest. Try to get members of the audience to locate the selected stars from your description. Follow this with the same star group projected on the screen. Now people can compare what they see on the screen and sky to confirm proper identification. Using a projection pointer or white stick you can indicate each star in the group to make sure that everyone is able to locate the features correctly.

If weather prohibits direct sky interpretation use sky transparencies to simulate what is seen in the sky. You should be able to stimulate enough interest so that people will plan to study the sky on their own when weather permits.

Sky transparencies will also be useful as supplementary material for lectures about any environmental topic. The most effective sky interpretation is that which is related directly to the surrounding region. The program need not be entirely devoted to the sky, but should discuss the sky in context with other interesting elements of the environment.

## IV. STUDY GUIDE FOR SKY INTERPRETATION

I. Study each of the phenomena in the following list.

Become familiar with each by observation if possible.

Locate and learn selected legends about each and

study changes in concepts across cultures and

through time. Be sure you understand the latest

explanations for each. Begin files of information

on each topic and start a picture and slide collection

on each including photographs you take yourself.

sky color and changes in sky color and  
lighting conditions.

clouds and cloud types

lightning

rainbows

aurorae

eclipses of the sun and moon

comets

meteors and meteor showers, and fireballs

II. Each of the objects and features in the following

list, except as noted, are visible to the naked

eye. Begin to observe each (as possible from your

latitude) with naked eye, binoculars and telescopes

as possible and appropriate (use proper precautions

in observing the sun) and continue your observations noting changes which occur through time (e.g., changing mid-day altitude of the sun and rising and setting directions of the sun through the year and changing positions of the planets, (including those not visible to the naked eye). Learn all you can about the physical nature of each object. Collect and learn ancient concepts about each and legends dealing with each. Where appropriate, make several lists ordering the objects according to (1) brightness (order in which they will appear and disappear in the darkening and brightening sky), (2) distances (note that the distances of some are constantly changing), (3) positions in the sky and visibility through the seasons. Be able to describe each, pointing out relationships to the earth and man and placing each in our current model of cosmic history. Begin files of information and pictures on each topic. Start a photographic slide file on each.

moon

planets (including earth)

Milky Way

### Stars

Sun  
 Sirius  
 Canopus  
 Alpha Centauri  
 Arcturus  
 Vega  
 Capella  
 Rigel  
 Procyon  
 Achernar  
 Beta Centauri  
 Betelgeuse  
 Altair  
 Aldebaran  
 Alpha Crucis  
 Antares  
 Spica  
 Fomalhaut  
 Pollux  
 Deneb  
 Eta Cassiopeiae

### Star clusters

Pleiades (M45)  
 Hyades  
 Praesepe (M44)  
 Double cluster in Perseus  
 Open clusters in Scorpius (M6 and M7)  
 Globular cluster in Hercules (M13)  
 Globular cluster in Centaurus (Omega Centauri)

### Nebulae

Great Nebula in Orion (M42)  
 Lagoon Nebula in Sagittarius (M8)

### Galaxies

Great Galaxy in Andromeda (M31)  
 Large and Small Magellanic Clouds

### Other objects

Crab Nebula in Taurus (not visible to the naked eye)

- III. Locate a list of all the constellations. Learn to identify as many as possible at your home latitude and when you travel to latitudes where others are visible add new ones to your list of familiar constellations. Pay special attention to the constellations containing the objects listed in II above (including the zodiac through which the sun, moon and planets move). Find out the origins of the names of the constellations and study constellation mythology from various parts of the world. Learn, by your own observations, to associate the constellations with the seasons. Obtain your own color slides of selected constellations. Begin a file of information about each constellation and objects within them.
- IV. Select a recent astronomy textbook. Set up a study schedule in order to study the text in detail in a definite period of time. Use other readings to supplement the text.
- V. Enroll in astronomy, meteorology and other courses related to sky interpretation as opportunities arise.

VI. Attend planetarium programs whenever you can. In addition to attending to the information presented, pay close attention to the methods used in presenting the programs. Afterwards list the sequence of topics used and analyze this from the standpoint of effective interpretation. List ideas gleaned from the program which may be used in outdoor interpretation. What changes are necessary? Find out what classes or other activities which might be useful to you are offered by the planetarium staff.

.....

"There is nothing constant in the universe,  
 All ebb and flow, and every shape that's born  
 Bears in its womb the seeds of change."

Ovid

.....

"Roll on, ye stars! Exult in youthful prime,  
 Mark with bright curves the printless steps of  
 time...  
 Flowers of the sky! Ye too to age must yield,  
 Frail as your silken sisters of the field."

Erasmus Darwin  
 (Father of Charles Darwin)

.....

## V. ADDITIONAL READING

The following references are very carefully selected to direct students of natural history interpretation to some of the best sources of information about the sky, its' objects and phenomena. The student must be aware of additional sources, especially those which become available after the publication of this book. In addition to using this list for personal study, encourage the availability of such materials at park sales outlets for the benefit of visitors.

Fieldguides, Skymaps and other books

Olcott's Field Book of the Skies, William T. Olcott, revised by R. N. Mayall and M. W. Mayall, fourth edition, G. P. Putnam's Sons, New York, 1954. An important guide for sky interpreters. Information about each constellation of the sky, emphasizing mythology and observation with unaided eye, binoculars and telescopes.

Star Maps for Beginners, I. M. Levitt and Roy K. Marshall, Simon and Shuster, 1964. A set of sky maps for each month of the year and associated information. Designed for the beginner. Includes only the brighter stars easily seen with the unaided eye. Designed for use at mid-northern latitudes.

Norton's Star Atlas and Reference Handbook, Sky Publishing Corp., 1969. A detailed atlas and descriptive material for the serious observer. The combination is one of the best available.

The Sky Observer's Guide, R. N. Mayall, M. Mayall and J. Wyckoff, Golden Press, 1959. A pocketbook with lots of illustrations on how to observe stars, moon, sun and planets with unaided eye, binoculars and telescope.

Stars, A Guide to the Constellations, Sun, Moon, Planets and Other Features of the Heavens, Herbert S. Zim and Robert H. Baker, Golden Press, 1956. A highly illustrated pocketbook for the interested beginner.

The Friendly Stars, Martha Evans Martin, revised by Donald H. Menzel and William W. Morgan, Dover, 1964. An easy-to-read introduction to the sky. Excellent for the sky interpreter.

Making Friends with the Stars, Arthur J. Zadde, revised by Theodore A. Smits, Barnes and Noble, Inc., 1964. Takes the approach suggested by the title in introducing the sky.

Cosmic View of the Universe in 40 Jumps, Kees Boeke, John Day Company, 1957. This little book presents an effective method for teaching the scale of the universe.

Pronunciations, Derivations, and Meaning of a Selected List of Star Names, George A. Davis, Jr., reprinted from Popular Astronomy, Jan. 1944. Available from Sky Publishing Corp. Very important for anyone teaching sky features.

Star Names, Their Lore and Meaning, Richard H. Allen, Dover Publications, 1963. A handy reference source containing hard to find information about star names. Useful, but not meant to be read from cover to cover.

Telescopes for Skygazing, Henry E. Paul, Amphoto, 1970. Information about the variety of small telescopes; how to select and use them.

The Finest Deep-Sky Objects, James Mullaney and Wallace McCall, Sky Publishing Corp., 1966. An excellent booklet describing deep sky objects for study with small telescopes.

The Universe of Light, Sir William Bragg, Dover, 1959. An outstanding book about sight and light. Topics range from vision to radiations from bodies in space. Comprehensive. Easy to read and fairly well illustrated.

Eye and Brain, The Psychology of Seeing, R. L. Gregory, McGraw-Hill, 1970. A very well written book on both the physiology and psychology of sight. Discusses light, the eye, the brain, brightness, movement, color, illusions etc.

The Air Around Us, T. J. Chandler, Aldus Books, London, 1967. A well illustrated book about the atmosphere and the forces within it, producing climate and weather phenomena.

Clouds of the World, A Complete Encyclopedia, Richard Scorer, Stackpole Books, 1972. A color illustrated book about classification of clouds with brief descriptions of cloud development.

The Lightning Book, Peter E. Viemeister, Doubleday and Company, Inc., 1961. An interestingly written, descriptive book on lightning. An excellent source of ideas for the sky interpreter.

The Nature of Violent Storms, Louis J. Battan, Doubleday-Anchor, 1961. One of a number of books in the Science Study Series.

The Thunderstorm, Louis J. Battan, New American Library (a Signet Science Book), 1964. The title indicates the contents.

#### Descriptive Astronomy Textbooks

Survey of the Universe, Donald H. Menzel, Fred L. Whipple, Gerard deVaucouleurs, Prentice-Hall, Inc., 1970. A very comprehensive descriptive text. An outstanding reference source for fundamental astronomical information.

Astronomy: Fundamentals and Frontiers, Robert Jastrow and Malcolm H. Thompson, John Wiley and Sons, Inc., 1972. A new easy to read descriptive textbook. A reasonably complete reference source for the sky interpreter.

Exploration of the Universe, George Abell, Holt, Rinehart and Winston, 1969. A widely used comprehensive elementary textbook in astronomy.

New Horizons in Astronomy, John C. Brandt and Stephen P. Maran, W. H. Freeman and Co., 1972. Sensitive to the type of information the sky interpreter is apt to need in a reference source.

#### PERIODICALS

Astronomy, Circulation Services, 1726 North First Street, Milwaukee, Wisconsin 53202. A beautiful astronomy magazine artistically describing the wonders of space. Excellent for sky interpreters.

Sky and Telescope, Sky Publishing Corp., 49-50-51  
 Bay State Road, Cambridge, Massachusetts 02138.  
 A monthly magazine on astronomy and closely  
 related subjects written for the amateur  
 astronomer and others interested in astronomy.

The Planetarian, Frank C. Jettner, Executive Editor,  
 Department of Astronomy, SUNY at Albany, Albany,  
 New York 12222. A quarterly journal of the  
 International Society of Planetarium Educators.  
 Articles on planetarium teaching and related  
 subjects. Suggested for anyone interested in  
 teaching astronomy and sky interpretation.

Griffith Observer, Griffith Observatory, P. O. Box 27787,  
 Los Angeles, California 90027. A small monthly  
 magazine with popular astronomy articles.

Graphic Time Table of the Heavens, Maryland Academy of  
 Sciences, 7 West Mulberry Street, Baltimore,  
 Maryland 21201. A graphical chart for quick  
 and easy determination of the times of visibility  
 of astronomical objects. Includes times of rising  
 and setting of the sun and moon and other objects.  
 Published annually and designed for use at mid-  
 northern latitudes. A very handy item for the  
 sky interpreter.

Sky Calendar, Abrams Planetarium, Michigan State University,  
 East Lansing, Michigan 48823. A monthly sheet  
 highlighting the most interesting visible astronomical  
 objects and events. Specially designed for teachers,  
 sky interpreters and others who want to be con-  
 tinually aware of what is going on in the sky.

#### American Indian Sky Lore

Information about American Indian concepts of the  
 sky is scattered in the literature of several disciplines  
 (Ethnology, Anthropology, Archaeology, History, Astro-  
 Archaeology, etc.).

The following references include sky legends and illustrate the intriguing legends which can be found by searching the literature of the Americas and other continents.

Indian Legends of the Pacific Northwest, Ella E. Clark, University of California Press, 1953. A wonderful collection of stories from the Northwest arranged in five sections: Myths of the Mountains; Legends of the Lakes; Tales of the Rivers, Rocks and Waterfalls; Myths of Creation, the Sky and Storms; Miscellaneous Myths and Legends.

Indian Legends From the Northern Rockies, Ella E. Clark, University of Oklahoma Press, 1966. An excellent collection with lots of sky lore.

Myths and Legends of British North America, selected and edited by Katharine Berry Judson, A. C. McClurg and Co., 1917. Filled with information for the sky interpreter.

Myths and Legends of the Mississippi Valley and the Great Lakes, Katharine B. Judson, A. C. McClurg and Co., 1914. Lots of information for the sky interpreter.

Tales of the North American Indians, selected and annotated by Stith Thompson, Indiana University Press, 1929. The comparative notes and references together with the text make this a valuable source.

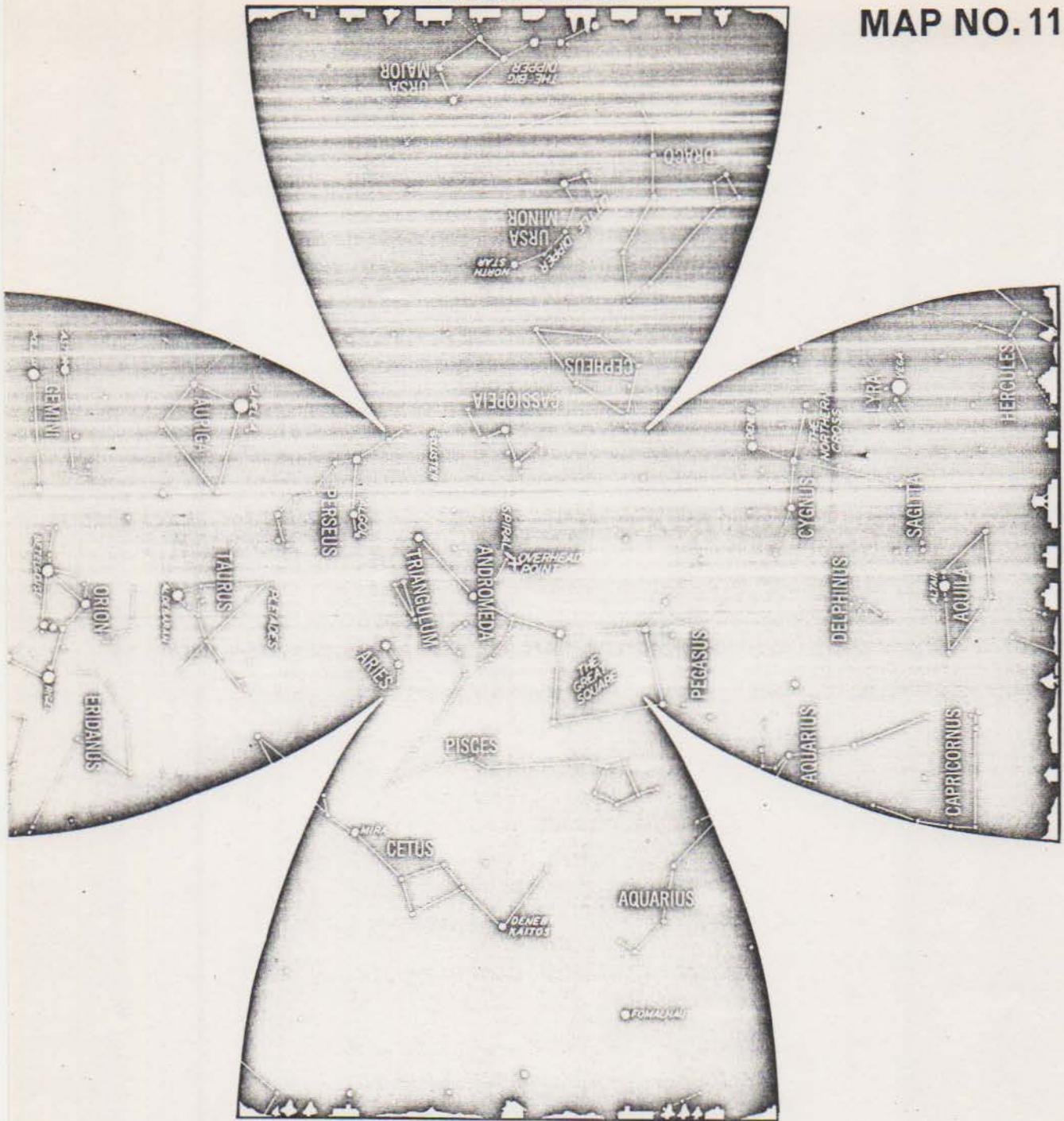
Pueblo Indian Religion (2 volumes), Elsie Clews Parsons, University of Chicago Press, 1939. One of the best sources on the Pueblos. Much information on ceremonies, cosmic notations, calendar etc. See the index (stars, sky, thunder, lightning, solstice, winter solstice, Orion, Pleiades, Galaxy, Dipper, etc.

Navajo History, edited by Ethelou Yazzle, Navajo Curriculum Center, Rough Rock Demonstration School, Chinle, Arizona 86503, 1971. The emergence story told in word and picture. Includes the account of placement of the stars in the sky, pp. 21-23.

Navaho Folk Tales, Franc Johnson Newcomb, Museum of Navaho Ceremonial Art, Santa Fe, New Mexico, 1967.

LOOKING NORTH

MAP NO. 11



LOOKING SOUTH

This map represents the sky  
at the following standard times

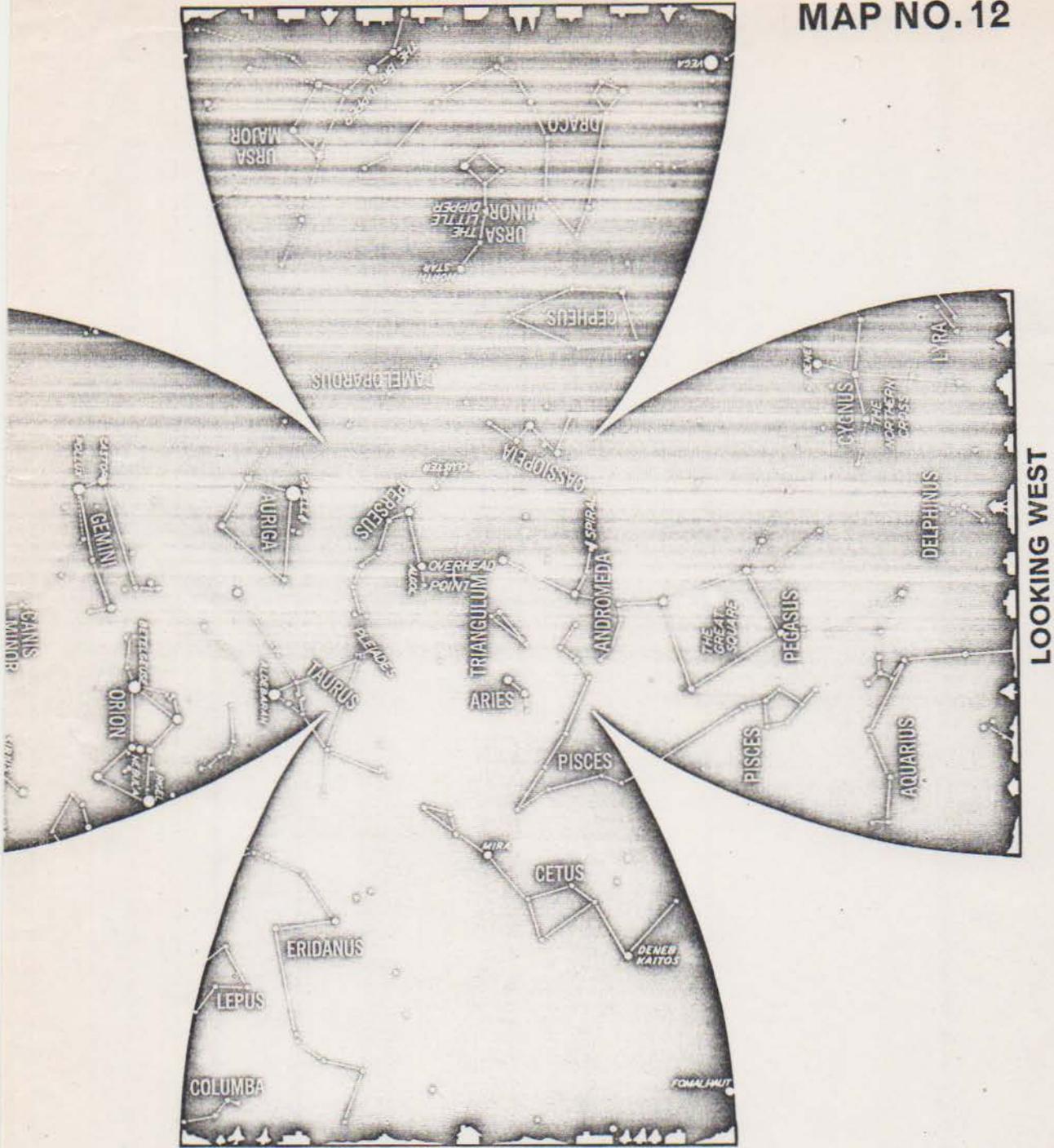
NOVEMBER 1 at 10 p.m.

NOVEMBER 16 at 9 p.m.

DECEMBER 1 at 8 p.m.

LOOKING NORTH

MAP NO. 12



This map represents the sky at the following standard times

DECEMBER 1 at 10 p.m.

DECEMBER 16 at 9 p.m.

JANUARY 1 at 8 p.m.

it to the center of her shield, and in reprints of this goddess the horrible face of Medusa, serpents for hair, can be seen. Ursa Major, Ursa Minor, Perseus, Pegasus, Cassiopeia, Andromeda, Perseus, Peg-

asus, and Cetus, the Sea Monster, are all in the heavens, strewn in December from the North Star almost to the southern horizon. These constellations are the illustrations for this epic story.

