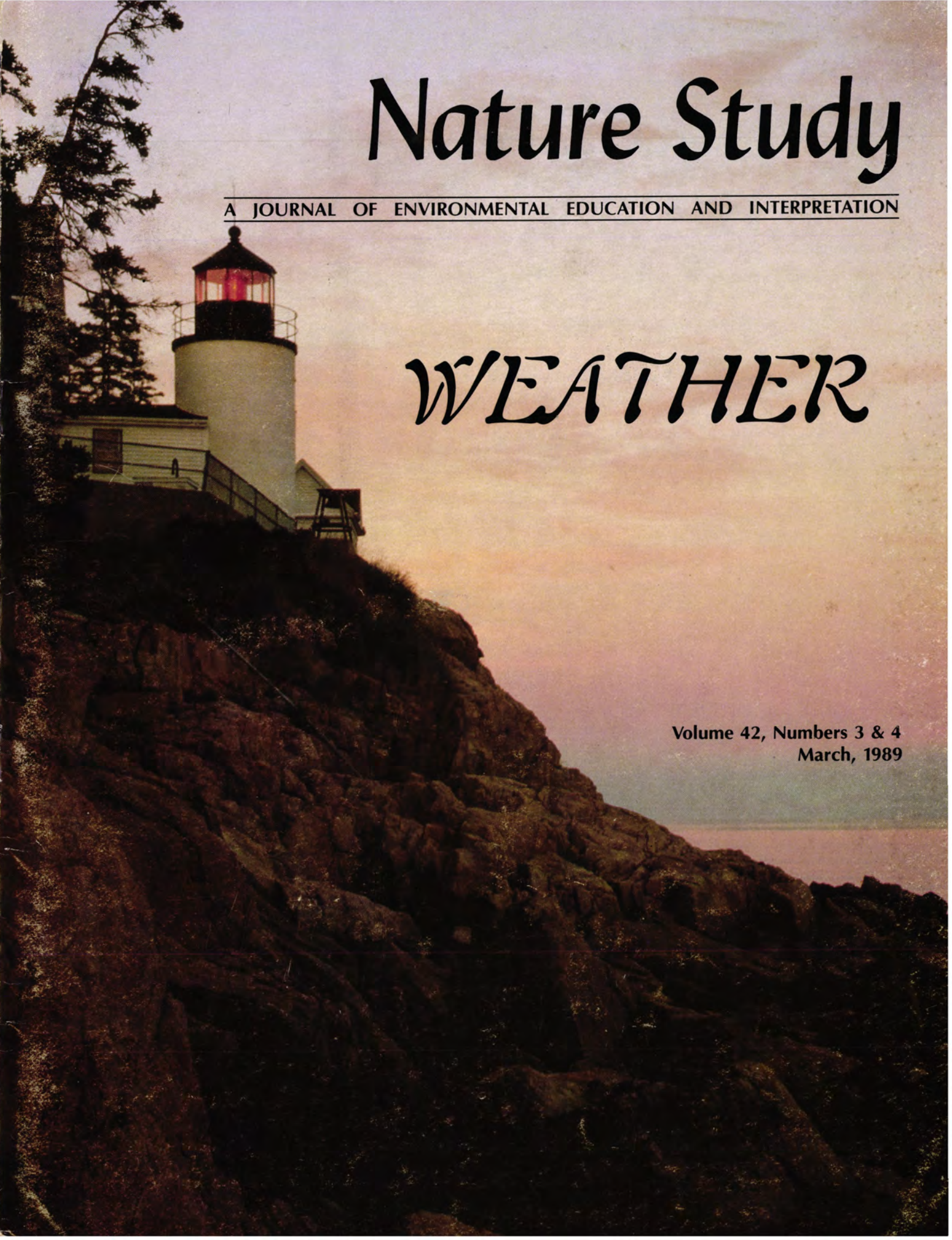

Nature Study

A JOURNAL OF ENVIRONMENTAL EDUCATION AND INTERPRETATION

WEATHER

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WEATHER ...

THE ABC'S OF WEATHER WATCHING

Joy Finlay

On our wall hangs a weather trivia calendar. Did you know that on April 16, 1987, the mild winter north of Calgary, Alberta, combined with unharvested grain fields, produced the greatest infestation of field mice in 40 years? Or, on April 30, 1984, the game between the Texas Rangers and the Toronto Blue Jays was delayed for 30 minutes by wind, before being called off. (Canadian Weather Trivia Calendar, 1989, Canadian Government Publishing Centre, Supply and Services Canada, Ottawa, Canada, K1A 0S9, $8.95 in Canada; or $9.90 in other countries. Produced yearly since 1984.)

The calendar itself is a fascinating compilation of interesting information on a most ordinary and popular topic. It was first produced as a gift of appreciation to the 2500 volunteer weather watchers across Canada who provide daily observations for the climate records. Like keeping a diary, the idea is appealing to students and family members alike, and my weather teaching box contains many samples of children's weather observations.

Beyond the trivia is an impressive appreciation for relating weather data with cause and effect. A weather report by definition is a statement of the weather conditions as they exist at a definite time and place, but a study of weather is a venture into a wide world of interrelationships, of cause and effect, connected significantly with the abiotic, biotic and cultural components of an environment. How often I have queried students about the significance of the temperatures, or wind, or rainfall they had recorded; how often I had prodded thoughts on "so what?" after recording "the what." If my students have enjoyed their revelations half as much as I have, then it has been worth it, for weather records take on new significance when related to that one last divergent question, What is the effect? What does it mean?

We called our weather activities the ABC's of weather watching. The "A" refers to the abiotic or non-living components. They are the air masses, lakes, forests, hills and valleys, or the air, water and land that affect and in turn are affected by temperature, wind, rain, or snow. The "B" is for biotic or living things, the plants and animals whose very lives are often affected by the vagaries of weather where they are. The "C" is for culture, the human component. Here we can indulge in personal responses to weather conditions or consider the effect on life styles. Our perception and sometimes misconceptions about weather tend to be formed under the influence of human concerns, comfort, needs, fancy, economics and enterprise. For spiralling concepts, a daily activity to monitor the weather conditions can lead to considering long term and global effects, such as acid rain, climatic changes, greenhouse effect, housing design and energy efficiency, or holes in the ozone layer.

"Reading the Weather" is a sample of the data sheet I have used, as a warm-up activity in adult workshops, as an organizing activity to start each day at camp, or for ongoing record keeping with students at school. Although all sorts of weather monitoring equipment may be made and used, three or four thermometers are all that are required.

Taking temperatures at several levels opens up unlimited opportunities for investigating micro-climates and a variety of temperature differences – in the shade, in the sun, above the snow, under the snow, in water, on bare ground, in the grass, in wet soil, or in dry soil. And then: how might different micro-climates affect the distribution, behavior, or survival of small living things? In the cold winter, for example, city birds such as house sparrows find a warmer micro-climate around chimney tops.

Under "Cloud Cover" and in the word "opacity", the quantity of light is introduced. To plants or animals, it is not the kind of cloud that affects them so much as it is the amount of light and solar radiation that gets through. In a sense, this is like taking a light reading to set a camera for taking a photograph. Day length, the reason for seasons and the Earth's tilted journey around the sun become topics to further explore. One year we tracked the Earth's path around the sun by marking the positions of sun in early morning on the east facing window sill. Of course, we found June 21 and Dec. 22 were the furthest points on either side.

READING THE WEATHER

Date, Time: _____

Temperatures			Wind Direction and Speed (use Beaufort scale)	Cloud Cover, Opacity	Precipitation	What effects? on soil, on insects, birds, mammals, plants, on you, traffic, others?
At shoulder height	Near ground level	Other				

Nature Study

PEOPLE AND THE PATTERNS OF PRECIPITATION

Robert S. and Helen R. Russell

We say that no life on Earth could exist without water but often fail to tune in to the process that makes water available. The amazing and singular property of water that enables it to change from a liquid to a gaseous state and back to a liquid at Earth's temperatures is responsible for the hydrologic cycle of evaporation, condensation, and precipitation. It is this that replenishes streams, lakes and ground water with clean water, and reverses the movement of water to the oceans, with all its dissolved and transported substances, both natural and human-injected. Except for infinitesmally small amounts of moisture from dew, frost, rime, and desalination of desert plants, the only source of fresh water for all life is provided by precipitation from the clouds.

This precipitation falls in highly diverse amounts in a great variety of patterns. If we average Earth's total precipitation in any given year we discover that every spot would receive roughly 100 cm. (40 inches) of rain. Eastern U.S. and Canada, western Europe, the bulge of Brazil, the coasts of northern California, Oregon and southern Washington, Japan, and South Africa do average this amount, an amount well suited to grow a variety of crops without irrigation. On the other hand, the coast of Peru and northern Chile and all of North Africa average 10 cm. (4 inches) or less, while the coast of South Chili, West Africa, Southern India, Zaire average 250 cm (100 inches) and northern India, Bangladesh and part of southeast Asia average even more.

Why this unequal distribution? The slant of the Earth's axis, the size of oceans, the mountains, the size and shape of the continents, the wind, the vegetation are all factors interwoven in complex ways. In addition to variations in the amount of rainfall there are variations in the time of rainfall with many areas having a wet and dry season. Furthermore some desert areas may go for several years without any rain and then have a torrential storm. All over the world precipitation patterns have a strong impact on comfort, crops and culture.

Try to match the rainfall stories on this map with the information and the locale. (Answers are on page 2.)

A. Rain prayers, ceremonies, dances and other religious activities are found worldwide in areas where rainfall is *low and seasonal.* In Africa where rain follows annual periods of drought it is women who perform the ceremonies because only women, like rain, give birth.

B. 250 cm. of rain falls each year in the wet season of both of these places but the one area suffers from floods, mildew, and bad physical and mental health of many people while in the other the rain is absorbed and distributed by trees.

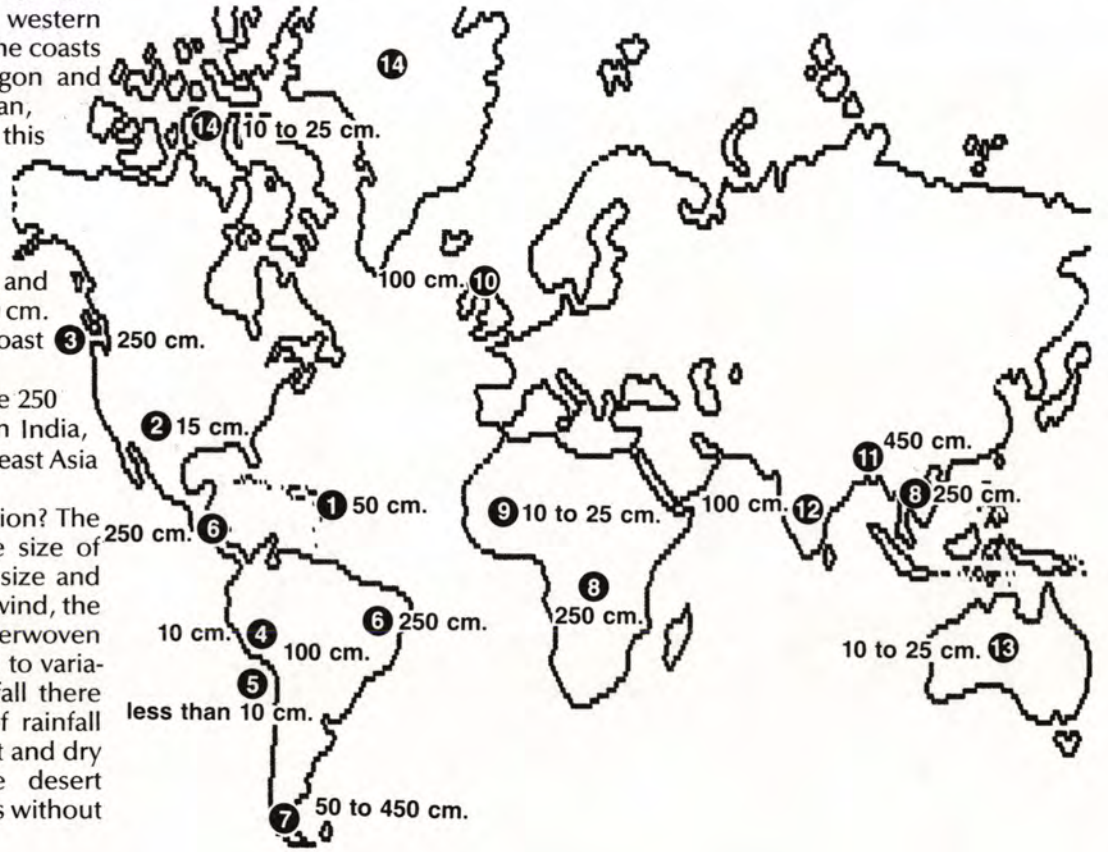
C. When Europeans came to the Caribbean they cleared the forests and planted sugar cane plantations on this island. Stripped of vegetation the hills lost their soil as torrential rains fell unchecked. Today this tourist island has only intermittent streams and a dryland vegetation and, except for one deluxe hotel which processes sea water by reverse osmosis, has its water, fresh vegetables and fruits, and all other foods delivered by barges from Puerto Rico.

D. Averages mean nothing in this driest spot in the world where in a 43 year period less than one inch of rain fell

E. The wettest spot in the world is always coping with floods and a soggy wet-season terrain, but it broke all records when in eleven months between August 1860 and July 1861 2,647 cm of rain fell!

F. Rain is sparse in the interior of this country and the population is largely distributed in narrow bands along the east and south coasts where 100 cm. of rain falls.

G. The ancient Anasazi civilization flourished until 1250 when dramatic



climatic changes occurred and rainfall decreased at which time they could no longer support large centers of population and abandoned their cultural centers.

H. In extremely cold parts of the world precipitation is low because there is little evaporation from the cold sea and land, the cold air cannot hold much moisture and the high pressure air masses tend to move toward the equator.

I. These countries have some of the most dependable rainfall in the world–seldom deviating from the annual average of 100 cm. distributed over the entire year–with a resulting beautiful landscape noted for its green-ness and its flowers.

J. Even though a country where monsoon winds blow may have the same amount of rainfall in a 12 month period the impact of 100 cm. distributed fairly evenly in the temperate zone is different from the same amount falling in often torrential, frequently drenching storms for six months following an equally long period of drying winds and no rain.

K. This group of islands with a total area of 28,473 square miles (slightly larger than West Virginia) has vegetation varying from a rain forest to grasslands to moss and wind-dwarfed subarctic trees. Its rainfall is equally diverse ranging from 50 cm. to 450 cm. This is not surprising since the topography varies from lowlands with lakes and moraines, to Andean peaks up to 7,999 feet in height and the land is buffeted by winds that come from the Atlantic, Pacific and Antarctic Oceans.

L. This temperate zone rain forest is a national park.

M. As the tropical rain forests in these two areas are cut to establish ranches to produce cheap beef for U.S. consumption, particularly in the fast food chains, populations of native peoples are destroyed, oxygen production is reduced, and soil erosion and leaching quickly damage both soil and waterways.

N. The architecture of these two ancient cities provides information on the difference in rainfall in this country. The Chimu city of Chan Chan on the coast with 25 square miles of decorated adobe buildings with flat roofs and the Inca city of Machu Piccui in the mountains built of stone with houses with gabled roofs.

PLACES

a. Peru
b. Cherapunji, India
c. Ireland and Britain
d. Northern Greenland and Baffin Bay Islands
e. Southern India
f. Zaire and Southeast Asia
g. Olympic National Park, Washington
h. Tierra del Fuego
i. Arima on the Chilean Atacama Desert
j. Brazil and Central America
k. Bandelier, Chaco, Mesa Verde, Canyon de Chelly in S.W. U.S.
l. Australia
m. St. John, Virgin Islands
n. Savannas of Africa

ANSWERS

1	C,m	8	B,f
2	G,k	9	A,n
3	L,g	10	I,c
4	N,a	11	E,b
5	D,i	12	J,e
6	M,j	13	F,l
7	K,h	14	H,d

□

Weather Words Search

Joy Finlay

R D R Y C M A P W N I M B U S
E V A P O R A T I O N A I R L
L A I R O A I R N I G H T C I
A I R F L O W X D U S K D O E
T E M P E R A T U R E L M N H
I S C R A A T O P W A R M D T
V T L E S I E S U D S S O E C
E R O C T N R A N D T T I N I
H A U I I N C U M U L U S S R
U T D P S Y C H R O M E T E R
M U S I C O H O T O P L U S U
I S A T U R A T I O N Q R T S
D O V A P O U R U V O W E T W
I U C T W E A T H E R A B T I
T T C I R R U S U N T O M T N
Y H H O T K I K I K H E A T D
N O O N O S K Y S T R A T U S

relative humidity
evaporation
temperature
wind
rain
precipitation
psychrometer
saturation
stratus
cirrus
sky
sun
clouds
water
hot
cool
moisture
vapour
south
east
north
cumulus
warm
air
condenser
wet
dry
weather
nimbus
heat
light
map
night
flow
noon

CLOUDS IN THE LANDSCAPE

John W. Brainerd

SCAPE and SCOPE come from a Greek root meaning "to look at" or "to watch". To help young people to study nature, to become students of the natural world and of people in relation to it, we try to get them to *look* and, we hope, in that process to *perceive*. As you stand over a student with a protozoan under the microscope, it is rewarding to hear, "Yes, I see it!" If the student then makes a drawing that looks somewhat like the animal, you know that there really has been at least some perception. Is that enough? Better, encourage the student to *watch* and to make a series of drawings (if, as you hope, the little animal is still alive and moving in its "*microscape*").

If you stand beside people looking at a *landscape*, you may wonder what they see. It is fun to ask them. Listening, you try to sense their perceptions in relation to "where they are coming from", (as the kids say about past experience and present thoughts while having a discussion). No two people will be seeing just the same scene, though they may give the same nouns, such as *house, hill, tree, clouds*. And some will just look while others watch, delighting perhaps in cloud shadows moving across the landscape.

Some fifty years ago I wrote a love poem whose first lines were "You watched the clouds that wisped across the sky / Presaging storm". Today my wife and I watch clouds often; we don't just look at them. Many people, too many, do most of their looking along a horizontal visual plane close to their normal eye level. Thus they miss much of what lies at their feet or lofts above their heads. What a challenge we have as environmental educators to get people to look down more and to look up more, for instance at clouds.

Of course clouds are not always above us. We enjoy looking down at dawn mists rising when cold air lies over warm water; we delight in watching fog creep in to fill a valley beneath our hilltop; we marvel at the billowing stratocumulus beneath the wing of our jet. But usually to watch clouds we must raise our sights from their usual plane of vision and, to promote

nature study, we should help others to raise their sights to heightened appreciation of clouds.

On camping hikes on hot, hot days when to the kids the dusty road seemed endless, when rolling a pebble in the mouth was scarcely able to moisten the dry tongue, canteens being empty, I'd say, "I see ice." Repeatedly. "Where?" Repeatedly. Having teased enough, I'd point straight up. "There!" Sure enough, there in the wispy cirrus clouds, ice crystals flung like the tails of white horses, marestail clouds. They could not slake our thirst for water, but they could increase the thirst for knowledge, cloud knowledge.

Cirrus clouds seem remote, in altitude. But often they are the vanguard, the *avant garde,* of other clouds to come, to delight or excite us with their immediacy. A lowering layer of stratus clouds may change our mood. The sky darkens. "Better close the windows." Or step outside to see the apricot sky still a thin streak low in the west as the front of a warm air mass rides up over cooler air. A change of temperature, humidity, and pressure can scarcely leave us personally unchanged if we are aware of what the atmosphere is doing. Looking up, you may see dark down-swellings turgid with moisture, 'mammae' the meteorologists call them. They can suckle parched earth or drench to flooding already saturated soil. One way or another, the landscape responds. Wise is the classroom teacher in the middle of any lesson to let the children go to the window to watch such clouds.

But more rewarding is to take the children outside, often, for even a very few minutes. Then they can look straight up as well as somewhat upward. Indeed, at many city schools between tall buildings that will be the only way to see clouds. In some re-

All illustrations by John W. Brainerd

gions, for instance our Pacific Northwest, gray stratus clouds may be present day after day. Then children should look forward to a change of the marine-born air; drier continental air, perhaps a polar outburst, will stormily change the dull gray layer, first to broken clouds scudding by, fractostratus in meteorological terminology, and then blue skies. Too bad to have to be captive indoors and miss that sky-show!

In blue-sky country such as the Pacific Southwest, Great Basin, and High Plains, during the summer when children should be outdoors with nonclassroomed freedom, encourage them to watch for the thermal uprisings which waft air high enough for whatever moisture is carried upward to be condensed into cumuli as the air reaches colder altitudes. Many other parts of the country can boast of cumulus clouds, those fairweather accumulations of puffy shapes challenging the imagination. But in the vast expanses of deserts and plains and along the Gulf Coast where distance over warm water provides space for observation, there one can watch the growth of cumuli into one great cell of upward-boiling cloud, dainty at first but destined to become a towering thunderhead of daunting shape and power. Few aspects of landscapes are as beautiful or as threatening.

As such a storm develops, the summit gleams brilliant white, unless near sunset resplendent with pink and orange. The contrast of values (as artists refer to lights and darks) is great, while against dark blue sky. The bulging crest then flattens as it reaches upward into the domain of jet winds which blow a shelflike projection down wind. (We used to describe this top as anvil-like, but few children today have seen an anvil.) Meanwhile condensate from the upflung air begins to tumble down as rain or, through much up-and-down tumbling, as hailstones. Now another shelf projects outward, from the base of the cell, this one gray, dark, ominous. Thunder growls and lighting zaps. Feel for a change of wind, a little breeze sucked toward the cloud. Fallstreaks of rain or hail are dropping from the advancing gray shelf; at first this curtain (termed 'virga') may evaporate before it reaches the ground, but soon the hot earth is pelted. Now one should watch from shelter, though not under a tall or isolated tree or tower which might be hit. If in 'tornado alley' of the Midwest, watch concernedly for a funnel cloud twirling down and lifting dust and debris from the earth. A cloud not just to be looked at: it should be *watched*, – and avoided!

When teaching outdoors about landscapes, analyzing their many components and trying to attain some synthetic thinking about how little patterns fit into big ones, I particularly enjoy a day when the sun shines brightly above large patches of cumuli whose shadows move quickly across a broad scene such as a valley and far hill seen from our hillside. I call attention to the contrasting values of dark and light as a cloud shades the foreground while the sun renders the middle ground more resplendent by contrast; or conversely, nearby earth, vegetation, buildings, whatever, may scintillate against a darkened background of subdued detail. The visual excitement of somberness and brilliance can stimulate broader interest in the scene; students may even enjoy thinking about whence come these clouds and whither they may be going as a local part of the great planetary swirls of air.

Similarly I enjoy a day when the front of a cool, dry air mass pursues a low stratum of moist air, thrusts under it and nips holes in it. The sun is waiting to beam through the fractostratus, its shafts of light fast-moving across the landscape. "Watch that beam there; it's about to shine on a grove of aspen!" – perhaps lime green with new leaves in spring or golden in autumn. "Wait . . . wait. Now: See the sun light up the little ranch house in the lea of its windbreak of Scots Pine." A thousand other noteworthy features of landscapes wait to be looked at, watched, recognized, and appreciated, if only we can throw light on them – with the help of sun and *clouds*.

For more cloud-knowledge and cloud-enjoyment:

Dunlop, S. and F. Wilson. *The Larousse Guide to Weather Forecasting*. New York: 1982. World-wide treatment of cloud formations. Slightly technical. Excellent cloud photos.

Lehr, P., R. Burnett, & Herbert Zim. *Weather – A Guide to Phenomena*

Photo by Candace Cochrane

Somewhere in Maine

(Reproduced with Permission from QLF/Atlantic Center for the Environment, Ipswich, MA)

and Forecasts. New York: Golden Press, 1965. Basics of cloud formations clearly presented for laypersons.

Ludlam, F. H. *Clouds and Storms – The Behavior and Effect of Water in the Atmosphere*. University Park, PA: Penn. State University Press, 1980. Highly technical treatment of cloud physics. Helpful for amateur cloud-watchers for sharpening their eyes and comprehension even if only by skimming the text and studying the pictures.

Roth, Charles. *The Sky Observers' Guidebook*. New York: Prentice Hall Press, 1986. A "renaissance man" gives us a bookful of material for sky appreciation and concern .

Rubin, L. and J. Duncan. *The Weather Wizard's Cloud Book – How You Can Forecast the Weather Accurately and Easily by Reading the Clouds*. Chapel Hill, NC: Algonquin Books of Chapel Hill, 1984. Give it a try!

Schaffer, Vincent, Jr. and John A. Day. *A Field Guide to the Atmosphere*. Boston: Houghton Mifflin, 1981. Authoritatively comprehensive.

There are many other good weather books describing clouds. And don't neglect the many books on landscape art which show how artists have seen and represented clouds. Have any modern artists you know of rendered the atmosphere in ways more to your like than have J. M. W. Turner and N. C. Wyeth?

JOHN BRAINERD *is a teacher, author, and artist.* □

THE WONDER MINERAL THAT COMPRESSES GEOLOGICAL TIME

Charles E. Roth

It causes us to re-evaluate what our understandings are about the nature of rocks and minerals; to see something familiar in a new light. Instead of being slow and ponderous in its transformations like most run-of-the-mill rocks and minerals, it is mineral for our time, it goes through its transformations relatively quickly; in time frames comprehensible even to children. This wonder mineral is common, generally abundant, and accessible. It is H_2O, our familiar friend, water.

Please refrain from your urge to have me committed and look anew at this wondrous substance. Like most minerals, water is a compound made up of two or more elements. Unlike most minerals, it exists in its molten, i.e. liquid, state within the normal range of summer temperature. This unique feature is what leads us to not think of it along with other minerals. However, when energy is removed from it and it transforms to a solid state, it shows all the normal characteristics we associate with minerals. It exhibits crystal structure, hardness, streak, color, cleavage, specific gravity and other properties of common minerals. You see, I'm really not crazy, water is a mineral. What makes it so unique is that it changes state within a smaller temperature range than most minerals. Other minerals can also be changed from solid to liquid to gas but only with a much higher energy input.

Somewhere in our education we are often exposed to the rock cycle; that process by which molten lava cools to solid **igneous** rock and when exposed at the earth's surface is weathered and eroded to form sediments that become compressed as **sedimentary** rock and may be further compressed and heated to further transform into **metamorphic** rocks. As crustal plates are forced downward beneath adjacent ones they may be reheated to molten state again completing the cycle. This is a process that takes untold eons of time and stretches the time comprehension of almost all of us. But in northern states and in high mountain regions, this whole mindboggling process can be seen and examined each year virtually between the autumnal and vernal equinoxes. Quite a different time frame. It happens with one kind of rock. By now you've probably guessed that it is water.

Photo by Helen Ross Russell

Footprints, like dinosaur footprints in sedimentary rock, provide clues to fossil information, like size, identity, rate and direction of travel.

I know, you are having trouble with the idea of water as a rock. I've just convinced you its a mineral and now I want you to accept that it is also a rock. Rocks are mixtures of minerals but there are often instances where large expanses of rock are just one mineral. These are mono-mineral rocks, like quartz outcrops and basalt dikes. Snow and ice, the solid forms of water, are likewise mono-mineral rocks. With these understandings about water as mineral and rock we can now examine the process of the rock cycle in the context of this marvelous rock/mineral.

During warm weather, water exists in its molten, or magmatic, state. It's only slightly wacky to realize that in every rain storm you are being inundated with hot rock. As the weather cools and energy is extracted from that magma, it solidifies into ice. The clear ice that forms on ponds, streams, puddles, and elsewhere is good igneous rock. Generally it has formed too rapidly to be crystalline and is glasslike.

Up in the sky, moisture in clouds may also lose energy, and it tends to form one of a number of shapes based on a six-sided crystal pattern. These grains of water mineral drift down through the ocean of air in much the same way as eroded particles of other minerals drift down through the liquid ocean to gather at the bottom as sediments. It is marvelous to stand in a snowfall and watch the flakes sift down, settle on the surface as a layer. If you watch closely you can see the flakes land and then settle in among the others, filling spaces and increasing the layer. They slowly pack together, all but the very topmost ones, to form a layer of sedimentary rock. The wind often brings dirt and soot to settle atop the layer. A new storm will cover this and this new sedimentary layer in turn may receive its share of dust and soot. If you cut down

through a field of snow and look carefully, the thin dark lines help you differentiate the separate sedimentary layers.

As layer upon layer builds up, the pressure is on and pressure generates heat. It is enough, along with heat absorbed from earth and sky, to cause the particles in the sediment to partially melt and then resolidify in different form – that is to metamorphize. The result is metamorphic snow, like corn snow, or ice. Metamorphic ice differs from igneous ice in that it is usually milky colored from air trapped between the grains of snow. If you cut through the ice of a pond after several snowfalls you will usually see both types of ice. On top will be milky metamorphic ice and underneath will be clear, or black, igneous ice. Of course, rain or sleet falling on sedimentary snow will bring necessary energy to create some metamorphic action. There are actually a number of forms of metamorphic snow/ice for which our language does not at present have specific words.

When we cut down through several layers of snow we discover that some are still soft and fluffy, some have hard, granular, or icy spots. This difference in hardness is like many of the rock layers throughout the American west. As winter winds howl over the landscape they pick up grains of snow and ice and blow them about. They act as the grains of sand do on non-snow covered lands and carve away at the softer rock or pile up in typical dunes. The diligent searcher in snowy landscapes can find buttes, mesas, natural bridges, dune fields and other erosional features that might otherwise require distant and expensive travel to observe. Their process of formation is essentially identical to those magnificent formations found in our great national parks, only the relative densities and resistances of the base materials and the time frame differ.

With the arrival of spring the available energy increases until all the mineral again becomes magmatic and the rock cycle is complete. This cycle, normally played out on a grand time scale has been played out in miniature and in comprehensible time once again.

During winter and spring there are several other related phenomena to be on the lookout for. Although water is essentially a mono-mineral rock, it is not always so. Because water dissolves so many things, it, like other minerals, may have impurities in it which change its properties slightly. Along highways you may see places where water seeps from road cuts and freezes in spectacular ice flows. These may often be of beautiful blues, reds and greens from impurities. Also in spring, as the water is first melting, as the snow cover leaves, mud remains. Beneath it is still frozen earth. By day the surface may be mud but at night it freezes. This sets the stage for a surface much the same as the tundra far to the north with its permafrost layer. It is noted for its peculiar cracking patterns. You will find the same far to the south during the brief time that this comparable phenomeon occurs. The processes are the same; only their duration is really different.

Photo by Helen Ross Russell

The removal of soft snow from beneath the hard crust in exposed areas creates mini-replicas of wind-sculpted canyons of the western U.S.

Thus, because of the marvelous properties of water, we can travel much more widely in our own northern neighborhoods and discover geological properties otherwise observable only on a much grander geographic and temporal scale. Get out and discover these things for yourself. Get in touch with the earth!

CHARLES E. ROTH *is Director of Educational Services for the Massachusetts Audubon Society.* □

WHEN ADDING IS SUBTRACTING
(Or Why Moist Air Is Lighter Than Dry Air)

Verne Rockcastle

Adding moisture to the air in the form of water vapor might seem to make the air heavier. After all, when you add something to almost anything, you increase the weight, right? Not always! Moistening air is an exception. To see why, try this simple activity as you read on.

Get a large, wide-mouth jar (preferably a glass gallon jar or large peanut-butter jar). Make sure it is clean and dry inside. Cut the neck half off a large, round rubber balloon and with a friend to help, try stretching the bottom half of the balloon across the top of the jar, fastening it in place with rubber bands. This is the closed container that you will experiment with.

Remove the diaphragm, pour in a quarter cup of water, and immediately seal the jar with the rubber diaphragm. Then wait a few minutes and watch what happens to the rubber diaphragm. Can you see it begin to bulge? The bulge is caused by *water evaporating and adding gas to the air that was already in the jar.* The water vapor in the jar is an *addition* to the nitrogen, oxygen, and traces of other gases in the jar. Since you made the jar air-tight after adding the liquid water, no gases can escape, and the pressure builds.

Compare this with a room in which the floor or the chalkboard is washed, and begins to dry. The pressure **tends** to build up as water vapor gets added to the air, but the room is *not* air-tight. So some air leaks out under the door, some out the cracks around the windows, some through heating ducts, and so on. But **what** air leaks out? Aha! It is mostly air consisting of more massive molecules than water vapor. Look at the following list of atomic and molecular **masses** of the common elements in air:

Element	Atomic Mass	Molecular	Molecular Mass
Hydrogen	1	H_20	18
Carbon	12	N_2	28
Nitrogen	14	O_2	32
Oxygen	16	CO_2	44

From this table you can see that nitrogen (about 80% of the air) and oxygen (about 20% of the air) both are heavier than water vapor. But, as a famous Italian scientist, Avogadro, showed long ago, in free air there are only so many places for molecules *of any kind.* If you force a water molecule into the air (by evaporation from a water surface), another molecule (probably nitrogen or oxyten) must get out of the way. As the floor or the chalkboard dries, and light-weight water molecules enter the air, more massive nitrogen and oxygen molecules are "pressured" out under the door, through cracks, anywhere they can get out of the way. The result: **the moist air actually becomes lighter!** It does so because molecules of one kind **displace** those of another, heavier kind.

As dry air blows across a lake, and water evaporates, the air becomes lighter. As air blows over fields and forests, and water enters the air by transpiration, light-weight water molecules **displace** heavier molecules and the air becomes lighter and tends to rise. Rising air can result in clouds, or storms – all because the air gets lighter as it gets moist. Addition of molecules, in the case of water vapor, is indeed subtraction (of weight). □

For every thousand feet increase in altitude there is an approximate 3 degrees F. decrease in temperature. Travelling upward from the tropics at the base of Mt. Everest, one moves into temperate zone temperature, crops, and vegetation, and finally into the tundra and the arctic. How many life zones can you pass through in mountains in your area?

On Watching the Board Dry

by Verne N. Rockcastle

I washed the board in the room today,
And pondered the wet that wouldn't stay,
But disappeared into the air
To fill the unseen spaces there.

How gaseous bits that were displaced
Weighed more than those that took their place;
How heavy bits went out the door,
To leave less mass than was before.

It seems that vapor, entering air,
Does not with other gases **share**,
But does molecular tit–for–tat:
That takes this space, this one that.

No crowding them in constant space;
Instead, their neighbors they **replace**,
As if each were assigned a seat
To keep molecular muster neat.

A water molecule, at mass eighteen,
Does not just sort of squeeze between
Two others, twenty-eight and thirty-two,
But does the space between eschew.

This insistent, lightweight molecule
Obeys an Avogadroan rule:
It moves more massive ones aside
With a vaporish, molecular pride.

In any room with board just washed,
Some molecules might well get squashed
If water molecules began to press
With nary a crack to ease the stress.

But they do find cracks, and squeezing past,
Decrease the total, 'til at last
The pressure in the room once more
Equals that beyond the door.

It's nice the way the air is made,
How molecules make vapored trade,
For if that simply could not be,
They'd put the squeeze on littl' ol' me!

BEFORE THE EQUINOX

Arnold Talentino

Springs begins in Upstate New York around February 1, at least at the base of my wooded hill that slopes southward into a marsh. I go out on a bright day after a heavy snow and there it is, some few witch hazel blossoms, so bright against the white monochrome and blue sky that I can't believe that I passed them by at one time. But these coppery-orange flowers are easy to miss just the same, because they grow along the twigs of an otherwise undistinguished shrub that blends like fine dust into the somber hues of the marsh. And at a glance, the four petals to a blossom, very narrow crinkles under an inch long, look like husks, no more descriptive than last year's oak leaves. The husks became flowers once when I was close enough to see insects flying at them. I rushed to spread the news, and still it's a secret. A few people around here might notice snowdrops pushing at the March melt, but most won't see spring until backyard crocuses, if then. The wonder of flowers above a foot of snow on a day of single digit temperatures doesn't fit the time-honored patterns; it hasn't been advertised, and it's not conveniently located.

February witch hazel, named *vernalis,* is one of two essentially southern species that have made their way northward to New York – or beyond, as in the case of the other, *virginiana.* Now I suspect that the taxonomist had Mississippi in mind when he named *vernalis,* but if nature wants to proclaim spring in the midst of a foot of snow, the announcement should be honored. The flecks of orange against the expanse of marsh and snow are spring's first song, whisper faint perhaps, but no less real than the light from constellations.

The song grows louder, though, and unlike that of most spring flowers, it lasts for several weeks, even if muted at times by caprices of weather. Pass the marsh again on a day of windblown snow, and the petals have wrinkled back, looking the worse for wear, dead even, victims of vernal precociousness. This is just prudence, however, and a momentary deep breath that will produce more volume. Come by again in sun and they're back, the same song now a little clearer, which in a couple of weeks will be a full chorus. And the many blossoms will fill the air with an exquisite sweetness, a fragrance as subtle and penetrating as spice. It can carry downwind for a hundred feet.

About the time that the witch hazel becomes a harmony of sight and smell, some time in the third week of February on a sunny morning after a night close to zero, a cardinal will add its voice. After months of a low profile in the hedges, calling only a quiet *chip* now and then, he will perch at the top of a small tree and give out with that high-pitched, whistle-like call that comes in four or five note sequences. The sound *clear, clear, clear, clear,* sharper than the frostly glint, laser sharp. All winter he had flashed cardinal against the snow, but the call adds a brightness to it, announces metamorphosis and new energies.

Once cardinals start, of course, other birds get the idea and soon follow, calling loudly to their own transformations. The bright mornings become a suite of trills and rondelets, and these singers brighten their looks as well. The redpolls and purple finches become redder, goldfinches begin to live up to their name, and the slate-colored dark-eyedjuncos seem polished. And there is more color down in the marsh now, as the quiet maroon of swamp dogwood takes on its strident luster, a loud counterpoint to the witch hazel. Then by the end of the month, color begins to move up the hillsides, as the red and silver maples bear the voice of the sun in tumescence of their buds – growing reddish, soon to flower.

As well as making flowers, the light of March 1 seems to have taken on a life of its own. Even if the days stay February cold, as happens some years, the late afternoon sun seems June bright, maybe brighter. Unsoftened and undiffused by grass and leaves, blinding off the snow, the afternoon light on a clear, cold day early in March, sharply in contrast with the shadows, seems to set the land in motion. On the north facing slopes the land undulates in shadows of its mounds and valleys; it flows downward, pulled by the long slanting shadows of the trees. The world is on the move. Above it the sky is an expanding dome, growing around the globe of the sun.

If there are one or two really warm days, though, balmy southwest winds bringing the temperature up to fifty or so, the next day the sky will be filled with geese. I frequently hear the first ones the night before, loitering on my way into the house, enjoying the sensation of a world bathed in a faint mist caused by the evening drop in temperature after a day of heavy melting. Somewhere beyond the dampness diffused in the yard light, I hear them, the sound of dogs barking from far off. Coming closer, the sound becomes geese, and as they pass over I look up, expecting to see them, surprised that I don't. So close sounding in the heavy air that they must be there just beyond the light, I think. Just look hard enough. Concentrate, and I'll see them, or at least a shape or two in a swirl of mist, mysterious aircraft teasing the eyes of a coast watcher. Disappointed again, I follow the sound to the north and go in. That night I hear them again from my bed, that faint call to the stars.

In morning the stars give way to geese, formation after formation, so many that I might hear that muted barking behind me at the same time that my eyes are straining toward the north, trying to find for one more moment that dim line, that trail of smoke disappearing toward the northern horizon. Some people here claim that

these first geese go the least distance north, nesting even as close as 50 miles from here at the Montezuma Swamp refuge, settling in as soon as some water opens. I doubt it, though, and I like to think of them as far fliers, Canada geese high over Lake Ontario with the marshes of James Bay in their eyes, going northward little by little behind the melt, following the rolling carpet of white. As they pass overhead, their boisterous honking sounds like a celebration, maybe of clear skies and easy winds, and the sun darkened silhouettes of the high fliers become almost white as they cross the zenith. To many others the honking sounds crazed; the geese can't be right with so much snow still on the golf course. But something has sent them. I see it on the clear days of high ceiling, when they shift position very little, keeping a tight formation, deep in their purpose.

Unless a substantial snow falls, robins will show up a week or so behind the geese. I always seem to hear the first one on a morning much like the first cardinal morning, clear and sparkling, but not quite as cold. I hear it for a few seconds without realizing, that *chirp* remotely in pitch like a cardinal's winter *chip*, but much quieter and without cardinal depth and timbre. Yet in the still air it is unmistakably robin, and the morning becomes suffused with the mystique of spring's official harbinger. The first robin! I walk carefully toward the sound, and there it is, outline of robin in that low tree over by the field where clear patches of earth show. Like many cliches that are occasionally welcome, the familiarity of robin breeds comfort, and determined to see it, I continue walking very slowly until the shape becomes a robin of wing and breast.

Of course, somebody else has seen one too, and that night the local paper gives the news to those without eyes to see or ears to hear. Then, taking away in the next column, the paper also reminds us that a few robins might sometimes winter here if they can find enough protection in a marsh or heavy woods. Don't be thinking spring on March 9; spring and the real robins are a couple weeks off yet. The paper's word of caution might be cordial advice to all those who thought the geese crazy, but when my spring robin shows up, it has flown in the geese's wake, followed their stars. Even if it had come out of a marsh, it is no less out, or up – no less a celebrant of renewal. Any first robin knows that spring has been coming for some time now, and it had better take advantage.

If robins are around, I know that down by the brook, in the conifers, grackles will be strutting in that stiff-legged way and calling spring in their rusty schoolyard-swing-sound – head and eyes gleaming. Robins are inspiring, but grackles are raucous clowns, the stuff of gaiety and a light heart; moreover, their spirit is untrammeled by words of prudence, since no one seems to notice them. These first grackles have sometimes arrived in the company of a red-winged blackbird or two, but the early redwings don't sport their wing bars or shrill calls. Instead they circle the marsh and simply make a husky *chek, chek*, a sound of consternation, I think, as if they were trying to figure out where a nest might fit between the tangle of last year's cattails and snowy hummocks of marsh grass.

Despite all this salutary activity, a couple of weeks will pass before the color and song of these first birds become widespread. They will have to endure at least one heavy snow, frequently more. As the snow falls, in large, agglomerate flakes of early spring, the birds huddle disconsolately on low branches of conifers, snow sometimes on their backs, looking as out of place as fish. Then a night of hard freeze follows, and at dawn only the feeder birds are around. The land seems heavy with winter, and I know that even the witch hazel will be playing dead again. I forget then about gaiety and inspiration, new life, and become pragmatic. Why be on the spot for the best nesting sites if you don't live to nest?

But these early birds seem up to an exacting world. A few appear around noon and emulate the old hands of winter, embracing the good luck of finding a feeder in the vicinity. These migrants stay on the ground, gleaning the chickadees' and sparrows' spendthrift spillage. Some others just stay in cover, fluffed out, guarding their energy stores and, I suppose, hoping for the best. Once I came upon a flock of about thirty, mostly robins, that had learned to make do in a grove of spruce mixed with white birch. The shallow snow, starting to melt on a clear day, was a commotion of leaves and twigs scattered from open pockets, as if deer had yarded. The place wasn't secluded enough for deer, though, and because I paused to avoid disturbing them, some went on feeding as I watched. They pecked and scratched at the edges of the pockets, pulling apart and tossing the layers of leaves. A couple seemed to be in a dusting position, as if digging for food with their wings. Like ducks in the patch of open water of a frozen lake, the group seemed to be doing all right.

By the time open patches start to show again in fields or the lee side of hills, the robins and grackles are back louder than ever. There are enough robins now to form small flocks, so that temporarily they are a gregarious lot, apparently not yet in the mood to claim nesting sites. And down by the creeks, amid the squeak of rusty swings, grackles again flash their heads and flaunt their amazing, delta-wing tails. The world has become a contagion of energy, a flash and purl of flowing water.

Not long after, on a day warmer than any since October, the robins will move to the tops of tall trees, each in its territory, and sing of their presence until everybody here seems to notice. There is talk of spring! I sometimes doubt, though, if that familiar lilting rise and fall of robin song, the eternal robin, prompts the talk, or even the watery pulpiness of the last heaps of snow. Perhaps the talk is simply a product of the calendar, that comfortable old device for taking time's measure and giving it shape. The equinox is only two days off, right where it was supposed to be; so, now, are the robins, conveniently answering to expectations. Now all agree that it is time for the bright shout of sun, for birds, for the sap to flow, and for flowers.

ARNOLD TALENTINO *is an English professor at SUNY-Cortland.* □

WIND WATCHING

Wind is air on the move, caused by differences in temperatures. Wind speed indicates how fast the air is moving. Air movement can be measured in several ways: feet per second, mile per hour, kilometres per hour, or in knots (nautical miles per hour). The Beaufort Scale and classification of a wind's force is used by the weather bureaus to describe winds.

Sir Francis Beaufort (1774-1857) of the British Admiralty first developed the table on wind forces in 1805 based on the effect of wind on sailing ships. As steam replaced sails, Beaufort's wind scale was adapted to terms more suited to steam. Beaufort's scale has been converted for inland use as well, one knot being equal to 1.2 miles per hour, and 1 mile equals 1.6 kilometres. With the changes to metric, Canadian winds are reported in kilometres per hour. No matter what the measurement system, the Beaufort Scale number is a reference to the effect of the wind's force at the time. Wind speed measurements are helpful in classifying the wind's effect, and for predicting changes. Exact measurements of wind vary as the air moves, depending on how high off the ground it is measured and other very local wind-breaking or wind causing factors that may exist. For example, the canyon effect of tall buidlings in a city's core are causing some interesting patterns of air movement. And shelter belts of trees have been planted on the prairies to help break the wind force of unobstructed moving air.

The following Beaufort Scale is useful for interpreting the wind's force in terms of its effect on each of us as well as the living and the non-living things over which a wind blows. The significance of wind speed is in its effect, beyond the measurement or classification of the wind itself. For ongoing activity, many more observations can be added and compared as signs of the wind's effects at different speeds.

□

The Beaufort Scale of Windforce

This chart was compiled by Joy Finlay with assistance from Environment Canada, Atmospheric Environment Services.

Beaufort Forces (scale number)	Description	Signs (observations, indicators)	Knots (nautical mph)	Miles per hr (mph)	Kilometers per hr (km/h)	
0	Calm	Smoke rises straight up	less than 1	less than 1	less than 2	Light winds
1	Light air	Smoke drifts slowly	1-3	1-3	2-6	
2	Slight breeze	Leaves rustle, wind felt on face	4-6	4-7	7-11	
3	Gentle breeze	Leaves and small twigs moving, wind extends light flags	7-10	8-12	13-19	
4	Moderate breeze	Papers blow, dust flies, small branches sway	11-16	13-18	20-30	Moderate winds
5	Fresh breeze	Small trees sway, wavelets form on water, loose snow drifts	17-21	19-24	32-39	
6	Strong breeze	Large branches move, umbrellas are hard to hold	22-27	25-31	41-50	Strong winds
7	Near gale, high wind	Whole trees moving, walking against the wind is difficult	28-33	32-38	52-61	
8	Gale	Twigs break off trees, blowing snow reduces visibility, walking is difficult	34-40	39-46	63-74	Gale winds
9	Strong gale	Loose parts of buildings are torn loose, TV antennae are damaged	41-47	47-54	76-87	
10	Storm	Trees uprooted, buildings damaged	48-55	55-63	89-103	Storm force winds
11	Violent storm	Damage is widespread, roofs blown off, driving made difficult	56-63	64-75	104-117	
12-17	Hurricane	Anything may go, devastation	above 63	above 75	above 119	Hurricane force winds

JOY FINLAY, an environmental educator in Alberta, Canada, is a member of the ANSS Board of Directors.

THE BUFFALO BLIZZARD OF '77

Nancy Acara

Believe it or not:

1. The infamous blizzard of '77 was not strictly speaking a lake effect storm.

2. Only about 3 inches of NEW snow fell during the blizzard.

Let us define "lake effect snowstorm" and "blizzard."

Buffalo is located on the eastern end of Lake Erie. The prevailing winds are from the west. Winds passing over the unfrozen lake pick up large amounts of moisture. When the temperature is below freezing, the moisture may be deposited as snow. The bands of snow are fairly narrow and depend solely on the wind direction. Usually, the bands hit the hilly regions south of Buffalo. This is ski country.

I remember one day when school was dismissed early because of a snowstorm. After cleaning six inches of snow off the car, I drove home. The storm abated as I drove north. After 3 miles, the snow stopped. After 5 miles, there was green grass and sunshine.

What is a blizzard? A blizzard is more than a snowstorm. To qualify as a blizzard, two conditions are needed: 1. The accumulation of snow must be more than 1 inch per hour; 2. The wind velocity must be more than 30 mph.

Visibility is almost nil during a blizzard. Because of slight variations in wind direction and the influence of barriers on wind patterns, there is much drifting. It is not unusual to have one area swept almost clean (for instance, a lawn) while another area 25 feet away has 4 foot drifts. Such are the perversions of Nature. Drifts can reach the top of a one story house. In general, with prevailing westerlies, north-south roads become clogged while east-west roads remain relatively clear.

The blizzard was not lake effect. November and December of 1976 and January of 1977 were far colder than normal. The lake froze completely over early. It could not therefore supply any moisture. However, the preceeding months were far snowier than normal. Four foot accumulations of snow covered the lake. All that was needed for a blizzard was wind.

The lake was not the only area with snow accumulations. The city had also received large amounts of snow and there were almost no periods of thawing. Street cleaning prior to the blizzard was poor. Many houses have no driveways and cars are parked on the street. As a matter of fact, many people with driveways also park on the street to avoid the work involved in cleaning their driveways. Most streets had daily alternate parking but this was more honored in the breach than in the observance. The result was that travel by car or bus was difficult even before the blizzard started.

The wind started about 11 a.m. on Friday, January 28. The Superintendent of Schools in Buffalo had listened to the weather reports and announced Thursday night that schools would be closed on Friday. This was truly fortunate. Can you imagine anything more terrifying than spending the weekend with one's students?

However, most plants, stores, and businesses did open. They closed after the blizzard started. Most people who worked short distances from home and who left shortly after the start made it home safely. Others had to remain at their workplaces all weekend. Some cars were abandoned on the trip home. The Skyway, an elevated highway near the lake, was a disaster area. Cars were abandoned and passengers led to safety. One policeman lost his life.

The storm was over by Saturday morning. The city was a mess – huge drifts of snow, abandoned cars, no place to put the removed snow. The mayor imposed a driving ban which was rescinded and later reimposed. Federal help was needed for the cleanup. Most Buffalo grade schools are located on side streets which were clogged with snow and abandoned cars. They were closed for 3 weeks until the cleanup was complete.

Not so for the suburbs. All houses have driveways. Street parking is banned at night and enforced by fines. Cleanup in the suburbs was complete by Sunday.

Even though the potential for a future blizzard still exists, it would probably not be nearly so great a disaster. Alternate side street parking is semiweekly instead of daily. Snow removal is more efficient. There are plans for possible emergencies.

For the past three years, Buffalo has scheduled a "winterfest" in late January. Many of the events have been cancelled because of (would you believe) lack of snow!

NANCY ACARA, *a former research chemist and Peace Corps volunteer, is a science teacher in the secondary schools of Buffalo.* □

First Snow

Tanya Oznowich

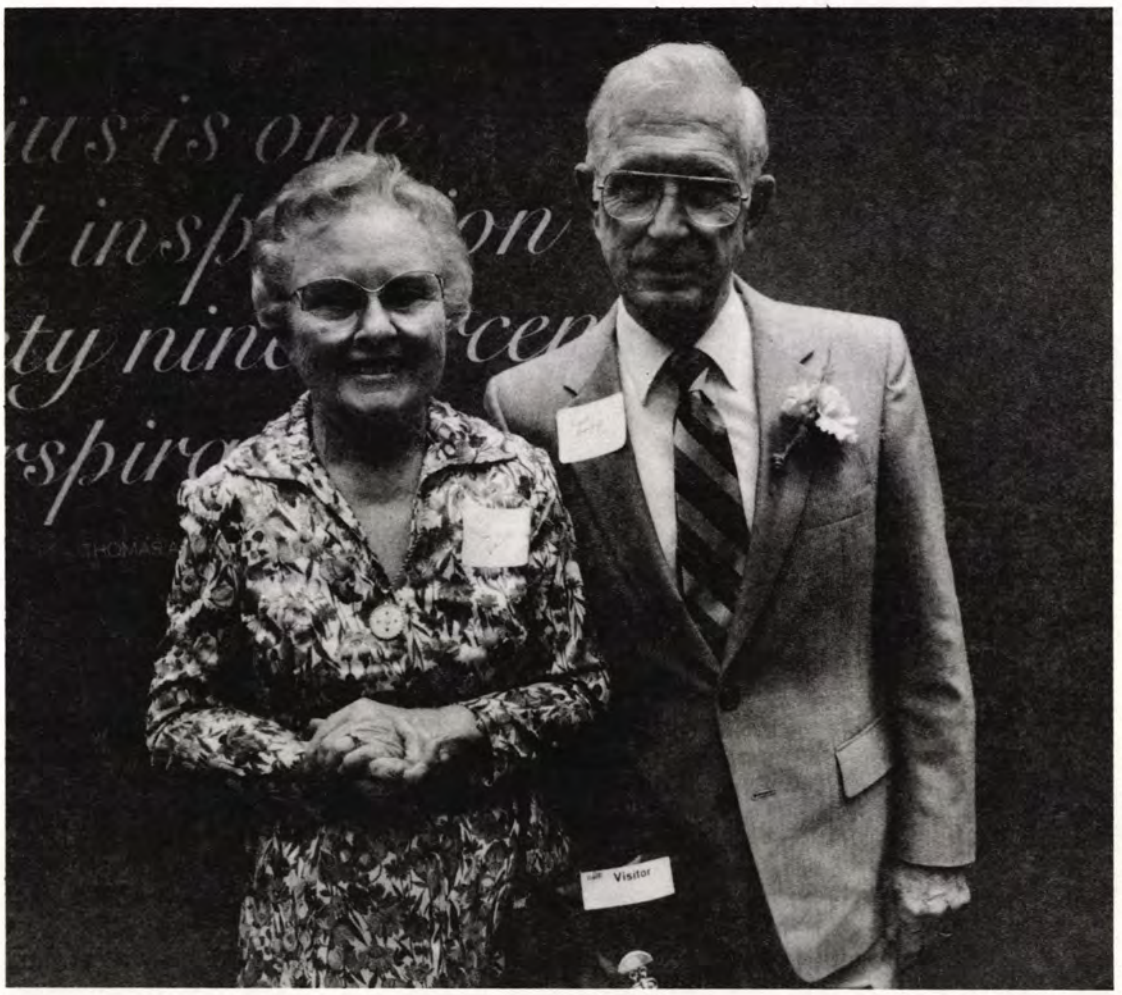
The late evening sunshine was hidden in snow
The flakes heavy-laden with light
The still air was fresh and tasty to breathe
And Autumn was hidden from sight
Still warm, the wet soil made slushy my trail
Which wandered me into the trees
And soon yet to follow the traces of deer
Whose journeys swept where they pleased.

The meadow-wrapped milkweeds wore hats fluffy white
That daintily swayed when I passed
The rabbits and mice left faint dancing paths
Whose wind-tossled steps would not last
And on from the meadow I entered the pines
Enclosed in their breath scented sweet
As shadows grew darker and settled down low
I followed the search of my feet.

The birds roughed their feathers and settled to sleep
As I sang a song of my own
And as I emerged from the pine's silhouettes
The wind blew me slowly towards home
Contentedly filled with my day's simple gifts
The lights in the distance shown clear
For all of the world I would not trade this time
Because all of my joys are found here.

Franklyn Branley Receives Eva Gordon Award

for Outstanding Contributions to Children's Science Literature



All photos by Ray Pfortner/Peter Arnold, Inc.

Mr. and Mrs. Branley

Frank Knight Presenting the Eva L. Gordon Certificate to Branley.

Kathy Blanchard Gave the Award Speech

Four Eva L. Gordon Award Winners: Helen Ross Russell, Franklyn Branley, Laurence Pringle and Vicki Cobb.

"BAD" WEATHER, GOOD PHOTOGRAPHS

Ray Pfortner

Fog and mist act as incredible filters, but be sure to bracket your exposures to get the most out of the opportunities they afford.

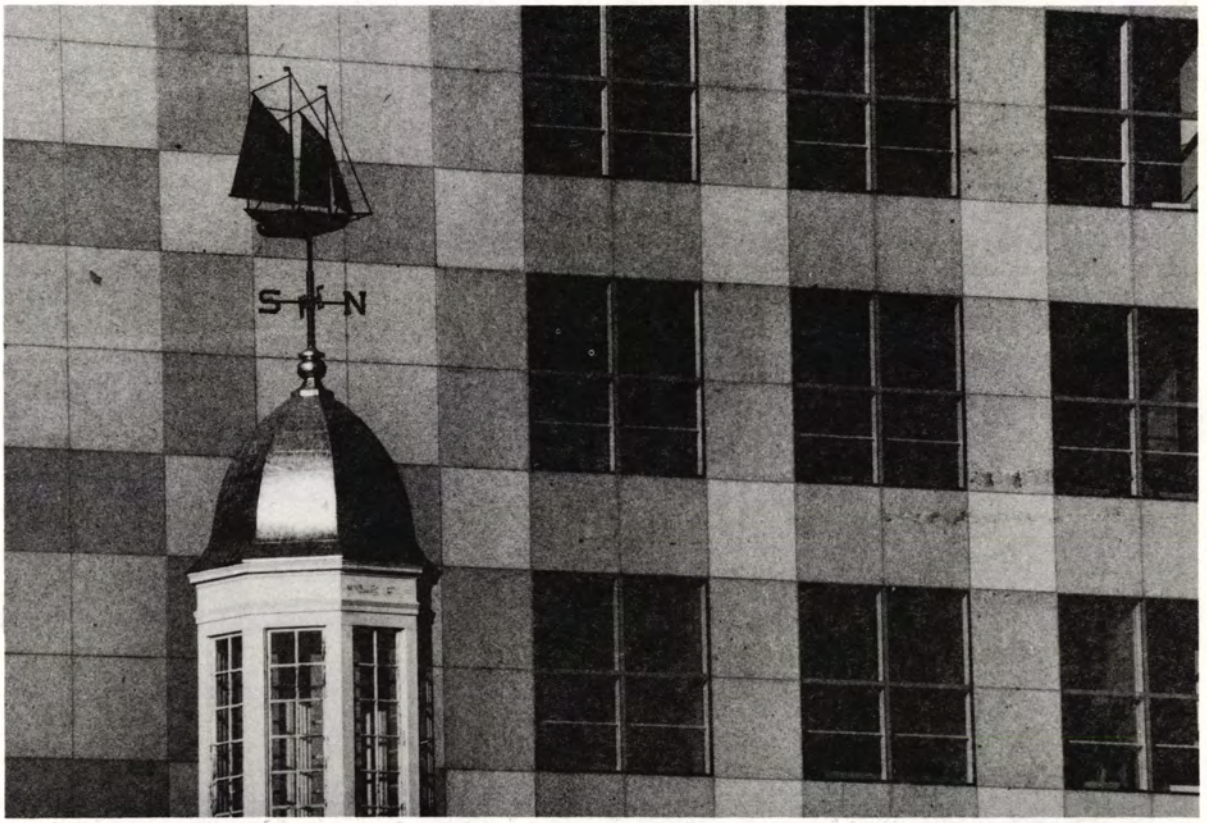
No matter how far removed from most natural things our ever-urbanizing/suburbanizing society seems to have gotten, one element of nature still exerts an almost-omnipotent force: the weather. We simply can not escape it. One day it keeps us moping indoors, only to pull us outdoors the next. We alternately praise and curse it. We dwell on it and plan by it. It makes – or breaks – vacations, weddings, picnics, graduations, and a host of other key events in a lifetime. The weather plays with our very psyche in ways we barely know.

As photographers, from amateur or professional, we are even more so creatures of the weather. After all, we paint with light, so weather conditions are of paramount importance. We all would most likely conjure up the very same images of the "picture perfect" day: blue sky, sparkling sun, clear horizon, and, of course, puffy white clouds. The sort of day for which most photographers yearn. I know one photographer in Germany who literally photographs according to his barometer. He goes out almost only on those high pressure days that offer just such "perfect" conditions. To some extent he is right, because these are the sort of conditions the consumers of photographs, from commercial clients to our friends and relatives, clamor for in our work.

But something is wrong here. A lot of very good photographers are missing a lot of the most exciting opportunities for photographs by putting away their cameras during "bad" weather. And everyone is rushing out on the few "good" days with more and more elaborate – and comparable – equipment, increasing competition and decreasing the variety of the resulting photographs.

All photos by Ray Pfortner/Peter Arnold, Inc.

Misty, foggy weather can dramatize the concern about air pollution in an urban setting. Try to make your photo simple and graphic and you will have a very useful image.



Concentrating on a given theme can often make for an excellent self-assignment. Weather vanes offer a fabulous variety and are often requested by consumers of photography.

Part of the reason is certainly "comfort level," the same reason all collections of photographs have more sunsets than sunrises. It is more comfortable and easier to be out at sunset than to get out at the crack of dawn. It is easier and simply nicer to photograph in the sun rather than in the rain or snow or cold. But it goes beyond this to that built-in bias in favor of "good" weather photography and photographs.

I believe that what most people consider "bad" weather – the rainy, foggy, misty, overcast, dewy, frosty and snowy days – is probably some of the best weather for photographs. These days are not the time to make the classic photographs of the Eiffel Tower or Big Ben or the Washington Monument. But they are the days to make the most memorable and exciting compositions, the days to explore a new look for your work. These are often the days to work close to home on local subjects that you may have taken for granted.

Of course, when you talk of rainy or snowy weather photography, everyone worries about damaging their equipment or at least likes to use this as their excuse for staying indoors. With a little care, most cameras can take at least as much exposure to nasty weather as you can. On those misty, rainy days just don't get your camera drenched. In the rain forest, I keep my camera on the tripod with a plastic bag over the entire camera and lens until I am ready to compose my next shot. Or you can keep the camera body in a loose plastic bag at all times with the lens peeking out through a hole cut in the bag. Be sure to keep the front of the lens free of moisture as you make your photograph. Ironically, a sun shade is very useful here

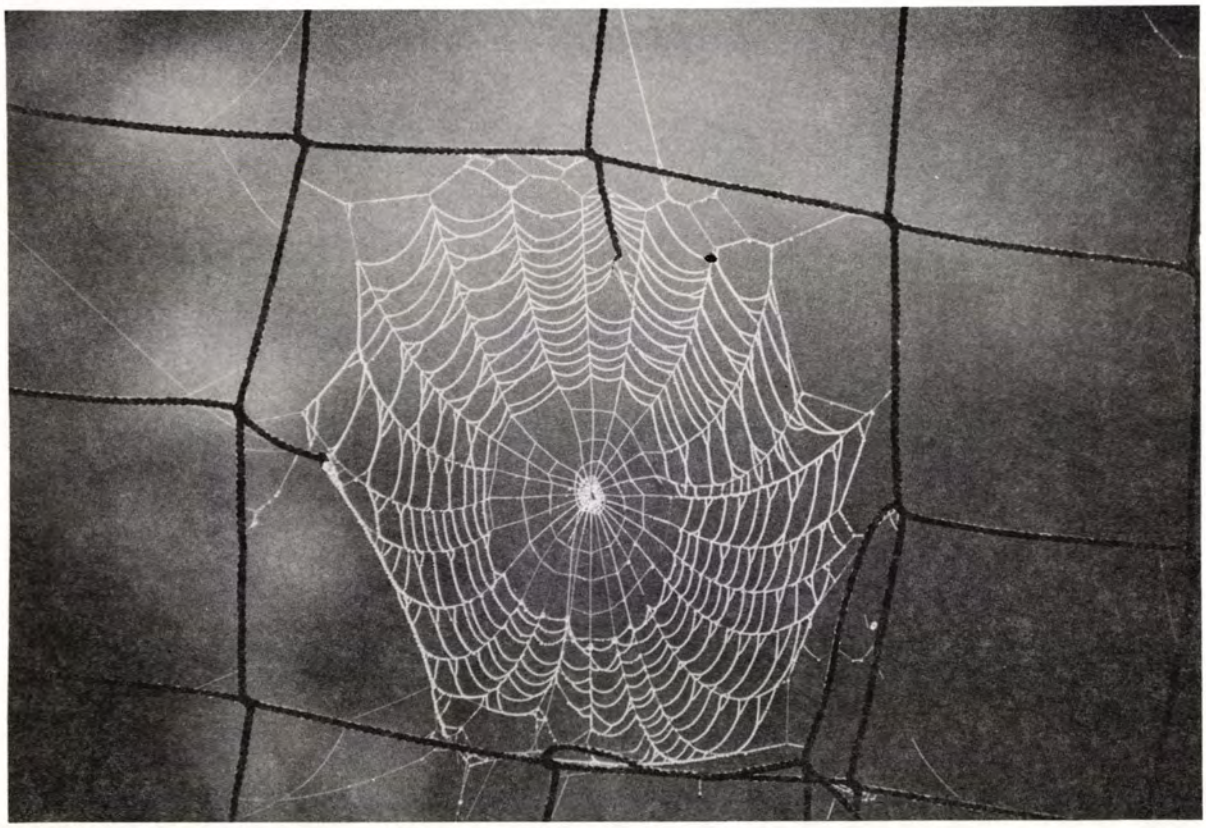
Don't let snow or rain or sleet stop you from getting out and making your photographs.

as are UV or skylight filters and some dry lens tissue stored in a waterproof pouch. When you come in out of the rain, just dry off your equipment as best you can to avoid corrosion.

On the snowy, cold days, moisture while outside is less of a problem, your own moist breath while focusing can ice up your equipment. Most normal cold is not a threat to lubricants, film, or batteries, although batteries would be the first to act up. To avoid battery failure on those extremely cold days, simply keep an extra set warm inside your clothing and be ready to swap batteries. Or invest in a remote battery pack, which you can wear inside your clothing. Of greater concern, really, will be your own hands and ears. Probably the biggest worry on a very cold day should be the moisture that can condense on – and especially in – a cold camera brought into a warm house. All you have to do is seal your camera in a plastic bag as you come back indoors. This will keep the condensation on the bag and not on your camera while the camera returns to room temperature.

Photographers specializing in gardens already know that overcast, even rainy days are the best days to photograph. Contrast is not too great, shadows not too dark or even nonexistent, and colors are rich and saturated. Water droplets add a new dimension to many common objects. And mist and fog can transform even the most mundane scene. But in the fog be sure to bracket your exposures (i.e., make two or three different exposures including the one your light meter suggests plus one stop over and one stop under). Often allowing a full extra f/stop (e.g., f/4 instead of f/5.6) is what it takes to make fog look as white as it really is.

Rain makes the rain forest, biologically and photographically. Your equipment there or on any rainy day anywhere can take almost as much of a soaking as you can.

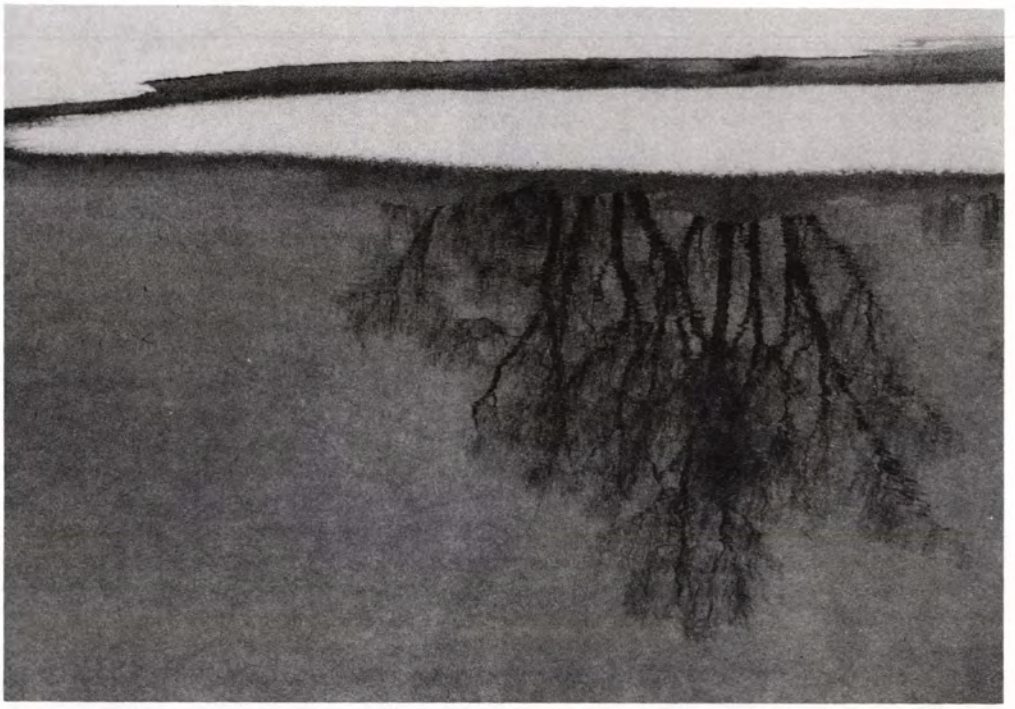


The dew after a rain can literally make a spider web visible to your camera, but it won't last long.

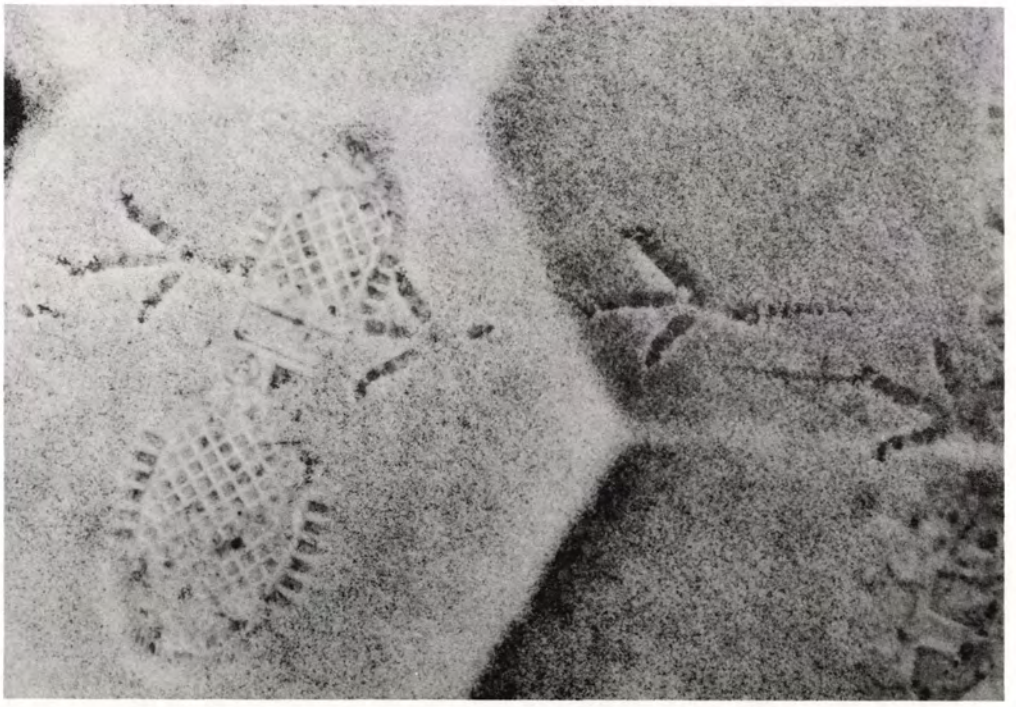
Wet foliage after a rain has a special quality and overcast days offer advantages of even lighting and not too much contrast.

Snow can also transform an everyday scene, reshaping the most ordinary of objects. But again, beware of exposure problems. Because of the way light meters are programmed, most render snow too grey. To capture the brilliance of snow, bracket your exposures, but usually an extra stop will do on an overcast day. Look for frost on windows and plants and of course ice patterns on any body of water. The early ice of first closure in late fall can be the most stunning. Try photographing snowflakes with your close-up equipment. Early in a storm, snowflakes can be found singly on many dark surfaces, or try catching them on dark velvet or cardboard prechilled to the outside temperature. And don't miss photographing rare occurrences like snow storms in the desert or unusually early in the fall or late in the spring. But shoot tight details as well as the big overviews. More often than not you will find that the overviews will not be as satisfying.

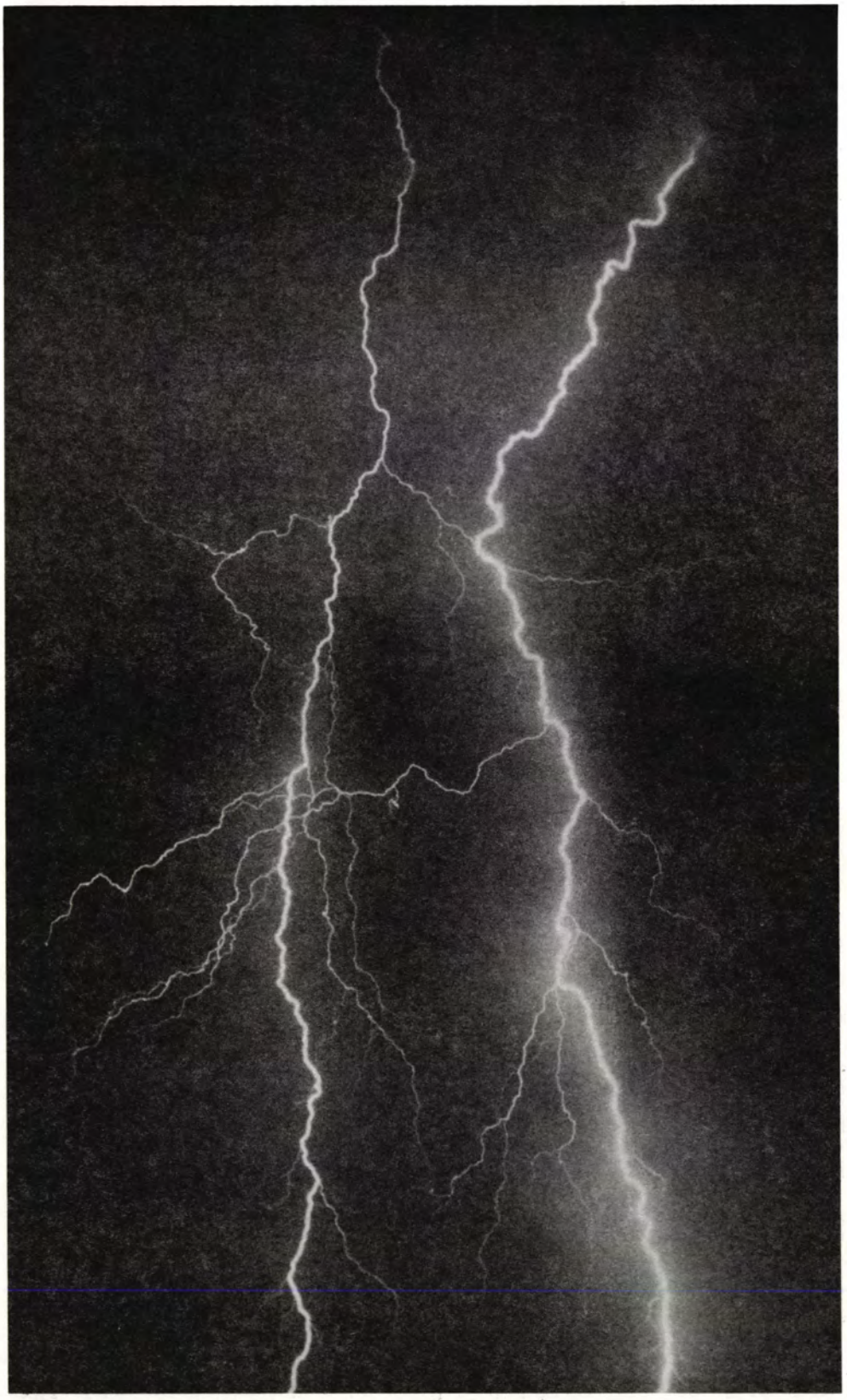
More extreme weather conditions are more challenging but potentially more rewarding – for prosperity, and posterity. Photographs of hurricanes and tornadoes, before, during and after, are difficult to come by and in demand. Lightening is probably one of the most dramatic and sought after subjects. In a good storm, it is not all that difficult to photograph. Just stop your camera down to a small aperture (e.g., f/16 or f/22) to reduce ambient light, and hold the shutter open using the "B" setting, releasing it after each bolt. Or try releasing it only after several bolts if they seem to be coming in slightly different parts of the frame. Blizzards and hail storms (including hail stones) and the damage they cause are also very valuable subjects for your photography.



Exposure compensation as well as bracketing become critical in winter photography - as does good composition.



To get the most out of "bad" weather photography, go out early in a storm and look for strong details.



On a brighter note, be sure to capture those extraordinary moments after any "bad" weather. Rainbows, for example, are a perfect challenge. Get to know where to look for them and use a polarizing filter to bring out all their incredible color. But don't forget to crop out a poor foreground or other distracting details you might leave in the frame in the haste of capturing these fleeting opportunities. Photograph the highlights in dew on plants and spider webs after the rain as the sun comes out. Do the same for new ice and frost and snow in the bright sun. Beware, snow in the sun normally requires at least 1 and usually 1½ to 2 extra stops of exposure to look as white as it really is. But experiment. In fact, try underexposing all of these by 3 or even 4 stops in bright sun to pick up only the highlights for what can look like a moonlit scene.

You might also try concentrating on just clouds, without foreground or any framing, especially after a storm. See how many different types you can capture, even just afloat in a bright blue sky. And don't forget to photograph the fabulous variety of weather vanes you come across in your travels. Photographs of them remain in demand and pose some interesting challenges in terms of composition and angle of view. To me they seem as much a part of the weather as rain or snow.

Weather really is the outdoor photographers best friend. And so-called bad weather offers us the greatest challenges and opportunities. So next time the weather gets "bad," don't curse it. Seize the moment and get out in it. I promise you, your photographs will never be the same again.

RAY PFORTNER *is Vice President of Peter Arnold, Inc., a stock photo library.* □

Lightning poses a special challenge, but all you need is a camera with a shutter that you can open.

Recycled!

Verne N. Rockcastle

On several occasions recently I have had the opportunity to relate Avogadro's number to a glass of water and to the recycling of water in a way that appears to generate thoughtful consideration. Students enjoy the exercise and are likely to share it with others, probably at the dinner table that night. Try it in your class. Give each student a glass or a cup of water. As they drink, point out at least two things.

First, ask the students to sip without letting their upper lip touch the water. It is difficult, if not impossible, for most people to do this. In ordinary sipping or drinking, you explain, the upper lip contacts the water, and the tongue is depressed inside the mouth. Because of the partial vacuum formed, atmospheric pressure forces water into the buccal cavity. From there, the water can be swallowed.

In the beginning, have the class concentrate on the mechanics of drinking. This will ensure that they drink the water before you read the second part of the exercise.

Write Avogadro's number on the board. You may want to describe how the number was determined, or have the class do some digging on their own to find out. In any case, explain that this number, 6.02×10^{23}, is the number of molecules of a substance in one mole or gram molecular mass of the substance. For example, one gram molecular mass of water is 18 g. Pour this mass of water in a beaker or a graduated cylinder (18 mL), and show the class just what mass of water contains Avogadro's number of molecules. By comparison, a glass containing 200 g of water has approximately 6.6×10^{24} molecules.

All the water on Earth—in the oceans, lakes, rivers, groundwater, atmosphere, glaciers, and organisms—equals about $1.4 \times 10^{9}\ km^{3}$, or 1.4×10^{24} mL, and has a mass of about 1.4×10^{24}g. This means that in a single glass of water there are about five times as many molecules as there would be glasses of water in all the water on earth!

The molecules in a glass of water have been recycled many times. The period for recycling is long: about 3,000 years on the average for seawater and up to 10,000 years for deep groundwater.

In the following verses I have taken some license for rhyming and for compressing the time scale. You might read this poem to your students to enrich their understanding of recycling as they (bravely) finish their drinks of water.

The glass of water you're about to drink
Deserves a second thought, I think,
For Avogadro, oceans, and those you follow
Are all involved in every swallow.

The molecules of water in a single glass
In number, at least five times, outclass
The glasses of water in a stream and sea,
Or wherever else that water can be.

The water in you is between and betwixt,
And having traversed is thoroughly mixed,
So someone quenching a future thirst
Could easily drink what you drank first!

The water you are about to taste
No doubt represents a bit of the waste
From prehistoric beast and bird—
A notion you may find absurd.

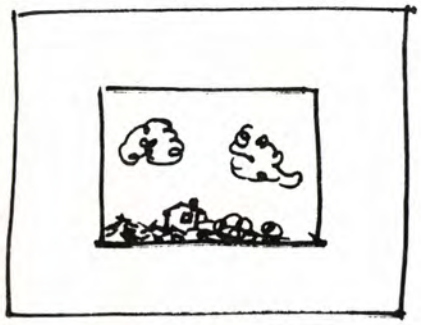
The fountain spraying in the park
Could well spout bits from Joan of Arc,
or Adam, Eve, and all their kin;
You'd be surprised where your drink has been!

Just think! The water you cannot retain
Will some day hence return as rain,
Or be beheld as the purest dew,
Though long ago it passed through you!

WEATHER WATCHERS – ACTIVITIES FOR YOUNG METEOROLOGISTS

Fran Ludwig

Without looking, what is the sky like *today*? If you can't answer, you're not alone. Jack Borden, a TV news reporter, interviewed 25 people on a Boston street one day. Not a single person could accurately describe the most dominant feature of our natural environment. Overwhelmed, Borden went on to found For Spacious Skies, a movement dedicated to the awareness and appreciation for the envelope of air that sustains us all. A teacher's guide entitled *For Spacious Skies* is a wonderful resource for interdisciplinary weather studies. Here are some sample activities adapted from the guide:



SKY FRAME

Weather Window. Choose a window from which you can see the sky. Each day throughout the year, ask a student to make a color portrait of the sky and landscape as seen through that window. Use the same size paper each time. Encourage students to notice changes from the previous day's picture. Fasten the portraits together to make a giant flip book of the year's weather.

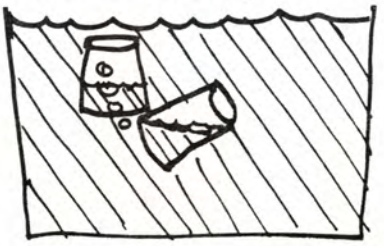
Sky Frames, Cut a 6" x 6" opening in a sheet of cardboard. Ask each student to observe the sky through the "sky frame" (helps to focus attention!) What color is the sky? Try to match the sky today with paint chip samples from the hardware store. Have fun naming the myriad hues – from white, blue, and gray, to red, purple, and yellow. Is the whole sky the same color? is the morning sky a different color than the noontime sky? Are clouds really white?

Cloud Watchers. Lie down in a comfortable place. Take a few deep relaxing breaths. What shapes are the clouds today? Encourage imaginative responses. "There's a cloud lion roaring in the sky today." Can you group today's clouds into fluffy, layered and/or wispy categories? Choose a cloud to watch for several minutes. How is it changing? Do clouds move or are we moving? How can you tell? If you think a cloud is moving, how could you find out how fast it is moving? (*The Sky Observer's Guidebook* by Chuck Roth shows a simple device for finding cloud speed. In addition, Roth's book is an excellent resource for more in-depth understanding of sky phenomena such as rainbows, constellations, life in the sky and how the sky has touched the spirit of humankind in poetry, music and religion.)

BLUE SKY DEMONSTRATION

Why is the Sky Blue? In a darkened room, shine a flashlight through plain water in an aquarium or clear shoebox. Can you see the beam of light in the water? Add a little milk to the container of water. Look at the shaft of light from the side. What color is it now? The grayish-blue appearance of the flashlight beam helps to explain why the sky is blue. Milk particles represent molecules of air in the atmosphere. Air is a colorless gas. However, when sunlight passes through air, the shorter wavelengths (the blue end of the spectrum) are scattered by air molecules. Blue and violet light is bounced around in the atmosphere and appears to come to us from all directions instead of from their source, the sun. The sky looks blue, and the shade of blue changes depending on the quantity of water vapor and dust in the air. Now for the grand finale! What color is the light from the flashlight? Look at the beam of light end-on through the milky water. What color is it now? Make the sun "set" by adding more milk. If air molecules (the milk) scatter blue light waves, then the red and orange light waves should be more intense when you look at the "sun" through the thickest layer of the "atmosphere." And they are – the beam from the flashlight is a sunset red! Why not get out of your classroom and take a field trip to watch the sun rise or set (also a great homework assignment). Add some dawn poetry to your weather journal.

Begin to study the properties of air in a more scientific way. Have a science fair on air: The Amazing Air Show.



POURING A CUP OF AIR

Pour air from an "empty" glass by filling a clear glass with water and immersing it in a clear container of water. Lower an "empty" glass, upsidedown into the container of water. Tip the "empty" glass and catch the bubbles in the upsidedown water-filled one. Challenge your audience to keep a tissue dry while you dunk it in water. (Remember the air pocket in the "empty" glass? Take advantage of it by stuffing the tissue into the bottom of the glass.)

DEFYING GRAVITY!

Defy gravity by keeping water in an upsidedown cup. Fill a cup to the very top with water. Slide a credit card or piece of plastic across the top of the cup. Carefully tip the cup upside down. Air presses in on the glass on all sides, including from the bottom up. Air pressure exerts more than enough force on the credit card to keep the water from falling out. You can figure out the force by multiplying the surface area of the card by 14.7

pounds/square inch.

Crunch a soda bottle – no hands. Fill a plastic soda bottle with very hot water. Empty the water out and quickly cap the bottle. Allow the bottle to cool at room temperature or (wickedly) help it along with some ice water or snow. Watch and listen. The hot water heated the bottle and the air in the bottle after it was emptied. Warm air in the bottle expanded and some spilled out. When the bottle was capped, air was prevented from entering the bottle as it cooled. The pressure of the air inside the bottle was less than the pressure of the air outside the bottle. Crunch.

CARTESIAN DIVER

You can make a Cartesian diver by filling a plastic soda bottle almost to the top with water. Fill an eye dropper with water so that it will just float in the soda bottle. Tightly cap the soda bottle. Command the diver to dive (while you squeeze the plastic bottle). The increase in pressure you created on the air and water n the bottle by squeezing is transmitted to the bubble in the eye dropper. Air in the dropper is compressed, allowing more water to enter the dropper. The dropper becomes heavier and sinks. How can you "command" the diver to rise? Directions for the obedient diver and other air powered marvels are in *Amazing Air* by Henry Smith.

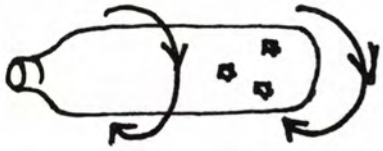
Weigh a basketball, then let the air out. Does air have weight?

Catch a bag of wind. Is there air everywhere? Is air the same everywhere? Can you make an air bag do some work? Can it support a book? A person? (Read *Air Is All Around You* by Franklyn Branley).

Be a wind maker. Place a piece of cardboard on the floor. Scatter puffed rice around the edges. What will happen when you lift the cardboard like a page of a book? What happens when you replace the cardboard?

PULLING AGAINST AIR

Line a wide mouth container (quart to gallon size is good) with a heavy weight plastic bag that fits fairly snugly. Fasten the bag tightly to the container with string or elastic. Now try to pull the bag out of the container. The "immovable force" you are up against is the weight of hundreds of miles of atmosphere! (Adapted from many exciting hands-on activities in *Teaching Science with Everyday Things* by Verne Rockcastle.)



TORNADO IN A BOTTLE

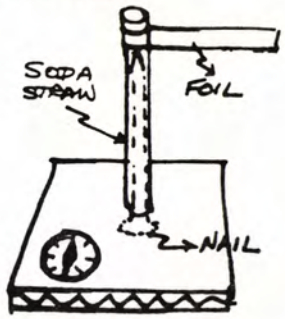
Make a tornado in a soda bottle. Fill a 1 liter plastic soda bottle almost to the top with water. Add one pinch of table salt and 1 or 2 small drops of liquid detergent. For dramatic effect, include some Monopoly houses or bits of plastic. Tightly cap the bottle and hold it in a horizontal position. Swirl the bottle (don't shake). Stop, hold the bottle upright and watch for the tornado in the middle.

Make a wind snake. Cut a spiral in lightweight paper. Tape a thread to the center of the spiral. Hold the spiral over a lit light bulb or near an open door. Does the spiral always move in the same direction? Could you use a wind snake to measure wind speed? An interesting mobile could be made from wind snakes.

Changes in the weather fascinate children. Take advantage of the interest by allowing them to become amateur forecasters! Meteorologists use scientific equipment to measure changes in the atmosphere.

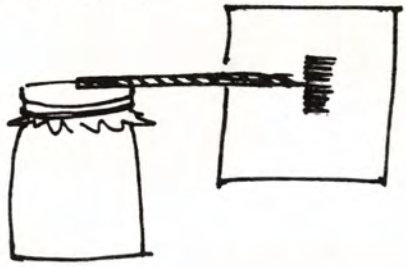
Have a temperature HI/LO hunt to gain experience in reading thermometers. Challenge the youngsters to find the highest and lowest air temperatures in the school yard on a sunny day. Are there any patterns in the findings? How have animals adapted to changes in air temperature over the period of a day? What would happen to the HI/LO patterns on a cloudy day or at night? (Adapted from OBIS activities distributed by Delta, Corporation.)

Many simple weather instruments can be made by kids from items around the house.



WIND VANE

To make a 10¢ weather vane, take a 3" x 3" piece of cardboard and push a broad headed nail through it. Cap the nail with a piece of soda straw. To the straw tape a strip of heavy duty aluminum foil. Check to see that the straw and foil move freely. Add a compass and you have a fine wind vane (also from OBIS). For another wind vane and anemometer, see *Weather Experiments* (A New True Book) by Vera Webster.



BALOON BAROMETER

Changes in air pressure can be detected by covering a wide mouthed jar (8-16 ounce size works) with a piece cut from a 9" balloon (blow the balloon up to stretch the rubber first). Tightly secure the balloon to the jar with string or an elastic band. Glue a soda straw to the center of the stretched balloon. Cut the free end of the soda straw to a sharp point. Mount a paper behind the free end of the straw pointer. Draw a scale with marks every ⅛ inch. Place the jar away from drafts

or heaters. Take readings from the scale to note the rise or fall of air pressure compared to the air in the jar. Readings must be taken at the *same temperature*.

Use the handy weather predicting chart in Naturescope's *Wild About Weather* to make weather predictions. Their paper model of the pasage of cold and warm fronts is sure to tickle young people. This publication contains a wealth of weather ideas. Gail Gibbon's book, *Weather Forecasting* beautifully illustrates the science of weather prediction.

Students love to "broadcast" their weather observations and predictions over the school public address system at announcement time. Having a "weather radio" (purchased for under $20 at Radio Shack) helps to check the student forecast against that of the pros – sometimes the kids have better results!

Natural materials can be used as weather indicators. A fun introduction to this topic is to investigate weather folklore. If cows lie down, does it mean rain? Do wooly bear caterpillars know what the winter will be like? *Nature's Weather Forecasters* by Helen Sattler and *A January Fog Will Freeze a Hog* by Hubert Davis reveal the truth (or fiction) behind these and many other superstitions.

Try your hand at "organic" weather instruments. Design a Rhododendron leaf temperature gauge. In cold weather they fold up against their branches (works in a freezer, too.)

Have you listened to a cricket thermometer? Count the chirps of a snowy tree cricket in 14 seconds and add 40. You will get the temperature in Farenheit degrees. What limitations are there in using a cricket thermometer?

PINECONE HUMIDITY INDICATOR

Can you use a pine cone to indicate humidity? Glue a toothpick indicator to one scale of a pine cone. Cut the cone and mount it vertically on a base with hot glue. Place a paper measuring scale behind the toothpick to measure changes in the angle of the scales. Try dunking a cone in water to see its reaction to 100% humidity (this will also work with Queen Anne's Lace seed heads, see Patricia Lauber's *Seeds: Pop, Stick, Glide.*)

Try an inch of colored water in a zip lock bag to demonstrate the water cycle. Tape the bag to a sunny window and watch the H_20 dutifully evaporate, collect in drops, then rain back down to the bottom of the bag. If the water put into the bag is red, what color is the rain? What time of day is best for evaporating water?

CLOUD IN A BOTTLE

A cloud in a bottle can be made by using a gallon wide mouth jar. Add a little water to the bottom of the jar and a bit of smoke from a match. Close the jar with a piece from a large stretched balloon. Tie the balloon tightly over the jar. Shine a flashlight through the jar. Pull the balloon up away from the jar (but not so hard to pull it off). Watch cloud droplets condense on the smoke particles as the air in the jar expands and cools. Push the balloon into the jar. What happens? Would you get a cloud if no smoke were in the jar? No water?

Measure rain with a homemade rain gauge. Use a straight sided jar such as an olive jar. Measure precipitation with an inch ruler. A thin layer of cooking oil in the bottom of the jar will prevent the rain from evaporating.

Snow is easily measured with a ruler. Melt a measured depth of snow. How deep will the melted snow be? Try filtering melted newly fallen snow. Where did all the particles come from? (Remember the smoke in the bottle cloud?) Try filtering rain.

Measure the pH of rain or melted snow. You will need a narrow range indicator, paper, pH 3.0-6.0.

Cover a plant with a plastic bag. Breathe into a clear plastic bag. What are sources of water in the air other than from bodies of water?

TERRARIUM

Make a mini-terrarium with two clear plastic cups. Add charcoal, pebbles, then soil to one cup until it is ⅔ filled. Plant a variety of mosses and other small plants. Add a slug if you wish. Water the little garden until the soil is just evenly moist. Invert the second glass and place it on top of the planted cup. Seal with clear tape. Keep the cup in a window out of direct sunlight. Watch the weather change in the cup. Under what conditions will it "rain"?

Weather is an exciting, ever changing study for people of all ages. With ozone layers and "greenhouse" gases making the front page, future voters will need a working knowledge and appreciation of the earth's atmosphere and its patterns. Why not start now?

Some recommended general references for young readers:

Branley, Franklyn. *Flash, Crash, Rumble and Roll.* (1987). Grades K-2.

— *It's Raining Cats and Dogs: All Kinds of Weather and Why We Have It.* (1987). Grades 3-8.

Burnett, R. Will *et al. Weather* (Golden Guide). (1975). Grade 3 up.

de Paola, Tomie. *The Cloud Book.* Grade K-2.

Ganeri, Anita. *The Usborne Book of Weather Facts.* (1987). Grade 2 up.

Milgrom, Harry. *Understanding Weather.* (1970) Grade 4 up.

Pringle, Laurence. *Frost Hollows and Other Microclimates.* (1981). Grade 4 up.

Schneider, Herman. *Everyday Weather and How It Works.* (1961). Grade 3 up.

Slote, Alfred. *Air in Fact and Fancy.* (1968). Grade 5 up.

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WEATHER FIELD TRIPS

Although we have weather satellites circling the earth, photographing and sampling the atmosphere with sophisticated instruments, and although one can obtain constant television weather predictions in all the major cities of the United States, conditions do not seem to have changed dramatically since Mark Twain issued his much-quoted statement that everyone talks about the weather but no one does anything about it. In fact, it sometimes seems as if the official prediction is no more accurate or not even as accurate as the prediction based on grandfather's rheumatism, Aunt Anna's bunion, or the local stock of weather lore.

This is because weather is a local matter; and while it stems from earth movements, sun spots, and moving air masses, it is also partly influenced by factors like lakes, parks, forests, and acres of asphalt. When we talk about weather, we are talking about the condition of the atmosphere at a given place and time.

We describe weather with words like cold, hot, warm, cloudy, dry, humid, freezing, snowy, rainy, clear, stormy, or windy. Over the years, we have developed a variety of instruments for measuring the weather and for predicting the future weather. Some are complicated, but others, like thermometers, are part of our everyday life. Sometimes a simple instrument is almost as effective and much more useful to the layman than an expensive, complicated instrument. For instance, the Beaufort scale, originated by Commodore Francis Beaufort in 1805 and reproduced here, is a useful chart for determining wind velocities.

When we talk about wind, we are talking about moving air. Air moves because of differences in temperature. As it moves, it also causes changes in temperature. In addition, wind picks up and carries water vapor, thereby influencing humidity. In other words, all weather is a series of interrelationships.

Code Number	Description	Signs	Miles per Hour
0	Calm	Calm; smoke rises vertically	less than 1
1	Light air	Smoke drifts; weathervane does not move	1-3
2	Light breeze	Wind felt on face; leaves rustle; weathervane moves	4-7
3	Gentle breeze	Light flags blow; leaves and small twigs move constantly	8-12
4	Moderate breeze	Small branches move; papers blow; dust is raised	13-18
5	Fresh breeze	Small trees sway; crests form on inland waterways	19-24
6	Strong breeze	Telegraph wires whistle; large branches move; umbrella used with difficulty	25-31
7	High wind or moderate gale	Whole trees in motion; walking difficult	32-38
8	Fresh gale	Twigs break; progress of people impeded	39-46
9	Strong gale	Insecurely fastened parts of houses torn loose	45-54
10	Whole gale	Trees uprooted; buildings damaged	55-63
11	Storm	Widespread damage	64-75
12-17	Hurricane	Devastation occurs	above 75

FIELD TRIP POSSIBILITIES

1. Wind can be experienced with many senses. Let children close their eyes and feel the wind. Can they smell the wind? Hear the wind? What things can they see that tell them about the wind? If they wet one finger and hold it above their heads, what happens? Does what they feel correspond to what they see?

2. If a single specimen of a tree or bush with wind-dispersed seeds grows away from the building on your grounds, divide the class into four teams. Have each team search in one direction to see how many seeds can be found on the ground in their quarter and how far from the tree the seeds can be found. Back in the classroom, their findings could be recorded as a picture or a graph. The figures on a graph will probably raise a new question: why does the wind blow more often and harder from one direction?

3. Set up a weather recording and forecasting station on your school ground. You can make a simple barometer from a bottle, a tight-fitting cork with one hole, two two-inch pieces of glass tubing, rubber tubing, wax, and cord. Fill the bottle with colored water. Fasten the two pieces of glass tubing together with the rubber tubing. Insert one piece through the cork. Put the cork in the bottle securely. Seal with wax. Invert the bottle. Suck the water into the tube. Tie the tubing to the neck of the bottle so that it forms a U. Hang the bottle in an inverted position in a cradle knotted of cord.

When air pressure is high, it will push on the colored water in the glass tube and the water will rise in the bottle. When air pressure is low, the water level in the bottle will drop.

With this barometer, a thermometer, the Beaufort wind scale, and the school flag to tell wind direction, a daily weather report can be written. As data is collected, weather prediction may also be tried. If the class feels the need for more information, they can obtain a cloud chart from the United States Weather Bureau or build additional equipment as described in some reference books on weather.

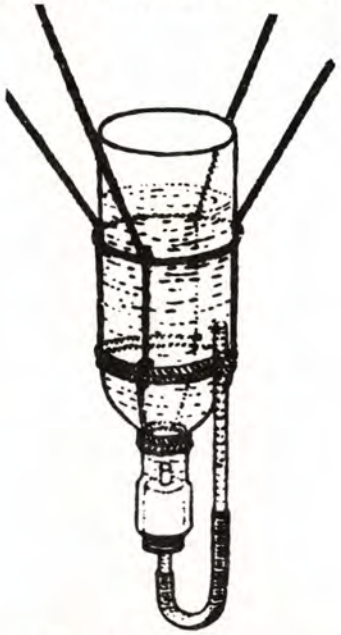
4. Immediately following a hailstorm, hurry outside to find the largest hailstones. Try to cut or break

a hailstone. Can you see the layered structure?

5. Microclimates can help with the understanding of weather. Compare the temperature and air currents in a grassed area and an asphalt area. What can this tell you about the weather in farmlands compared to the city? Can you find a microclimate that could be compared to a forest? A desert?

6. During a snowstorm, go out and catch snowflakes on dark colored paper, or, for longer examination, on black cloth dipped in water and frozen in the school freezer. Examine the flakes with a hand lens. The larger flakes were formed slowly in the lower, warmer clouds. The smaller flakes froze quickly in the high, super-chilled clouds. Can you tell where the snow is coming from? Notice that the larger flakes are more ornate, whereas the smaller flakes, which come from cirrus clouds, tend to be simple hexagons. (Simple flakes are wind-tossed and broken so their six-sided quality is destroyed.)

7. Snow and frost are frozen water vapor. Examine both. What have they in common? Ice and sleet are frozen liquid water. How are they alike?



BAROMETER
When children make equipment like this water barometer and set up their own forecasting station on the school grounds, they gain an understanding of water relationships.

MONITORING ACID RAIN

Gary Boltz

I initiated the study of acid rain with my sixth graders by having them test a variety of liquids like lemonade, coke, milk, and apple juice with the pH strips supplied in the acid rain monitoring packet. All students had experience with comparing their strips to the pH chart and taking readings.

We then made a 9x4 foot wall chart with a pH scale. We cut paper raindrops, labelled each one with a substance tested and its pH reading, and arranged them on the chart from highest acidity to alkaline.

I then taught a lesson using the Audubon information on how acid rain affects fish, concrete, cars, etc. After this we were ready to lay out our acid rain monitoring program. We collect samples on every rainy school day. To do this we cover an area with a piece of plastic to prevent splash, and set a bucket on it. We also have a rain gauge set up and record the amount of rainfall.

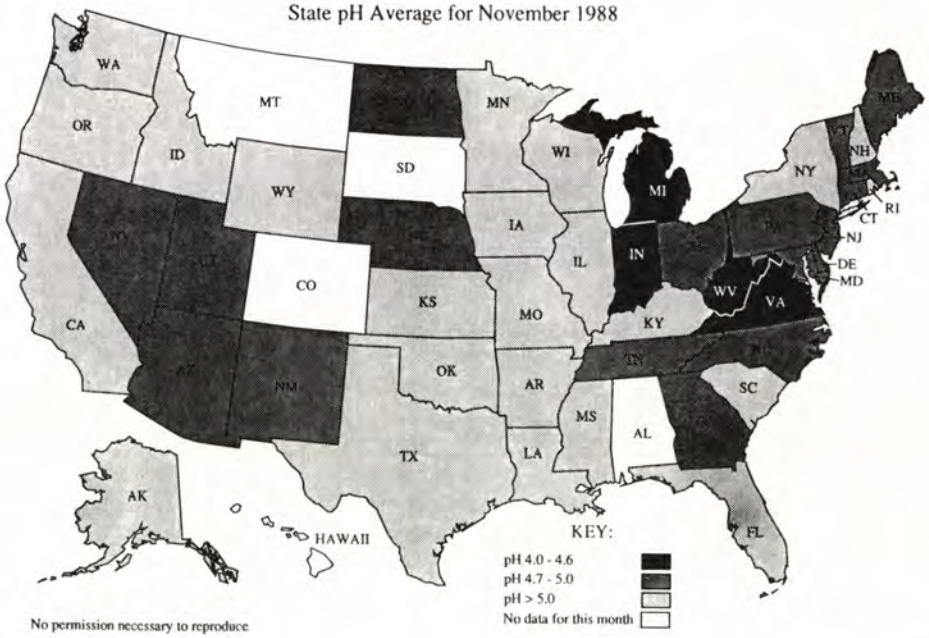
The students test the rain and record their findings. I also check every sample. We record the results on a chart in our classroom. I phone the results to Audubon National headquarters in NYC, and mail a postcard report to Bodega Research Lab at the University of California.

We receive a monthly newsletter with a map of the U.S. with the pH readings recorded. The newsletter also provides information on what to do for publicity and ways to influence legislation.

At present there are 270 monitoring stations operating in the U.S.–some are schools, many are individuals. This is a simple and inexpensive way to get people – even elementary school children – involved. [Ed. note: to join this project see information on this program in the Alliance for Environmental Education column.]

GARY BOLTZ *is a sixth grade teacher in Palmyra, PA schools. He is also president of the Quittapahilla Audubon Society.* □

NATIONAL AUDUBON SOCIETY
Citizens' Acid Rain Monitoring Network
State pH Average for November 1988



ENVIRONMENTAL EDUCATION TIPS

Weather Activities

Audrey H. Brainard

WHAT IS WEATHER?

Squirt some water, from an empty detergent container, into a heat resistant container. Capture some air in a plastic bag and add to the water. Secure a translucent balloon or plastic bag over the opening of the container and place the container on a hot plate or heat source labeled "Sun." Take precautions so the balloon or plastic bag does not come into contact with the heat source and melt.

The balloon or plastic bag will inflate (increase air pressure), water vapor will condense and rain will occur (the water cycle).

Weather is the condition of the atmosphere in terms of heat, supplied by the sun, air pressure, and amount of moisture. Winds are created by the uneven heating of the earth's surface by the sun. If the earth's atmosphere were never heated or mixed there would be no changes in weather. Heat is the spoon that mixes the atmosphere to make weather.

HOW IS EARTH HEATED?

Place thermometers under different pieces of colored construction paper set in the sunlight. Record their readings every 15 minutes.

The sun is the source of most of the earth's heat. About 43% of the sun's radiation which reaches our planet hits the earth's surface and is changed to heat. The rest stays in the atmosphere or is reflected into space. About 42% is reflected back to space and 15% absorbed by the atmosphere.

A typical cloud reflects 75% of the sunlight striking it. Snow reflects 75%, dry sand 25%, water between 4% and 40% depending upon the angle at which the sun light hits it, grassy field 10-20%, plowed field 5-25%, dense forest 5%.

WHAT IS AIR MADE OF?

Use a gallon size plastic bag, nonziplock, to gather some air. Close it with a twistem. Ask: what does it look like? Can you see through it? Does it exert pressure when you push against the side of the bag? Would it float on water? Would it float in the air? Does it have taste? Smell?

Air is a mixture of many gases: nitrogen 78%, oxygen 21%, the remaining 1% is carbon dioxide, hydrogen, and rare, inactive gases; helium, neon, argon, krypton, and xenon.

WHEN PEOPLE TALK ABOUT THE WEATHER, WHAT DO THEY SAY?

Brainstorm types of weather with the class. Classify those that occur together and/or during a particular season. Collect pictures showing different types of weather. What people usually talk about is water in its liquid or solid form.

HOW DO WE FIND OUT ABOUT THE WEATHER?

Tape a weather broadcast to use in class. Most people listen to or watch weather broadcasts.

WHAT DOES A WEATHER BROADCAST TELL PEOPLE?

Listen to the tape and list the types of information given. A weather broadcast gives the air temperature, pressure, humidity, the direction and speed of wind, kind and amount of precipitation, condition of the sky, and frontal movements.

WHO GIVES THE WEATHER REPORT?

Have students research the educational requirements to become a meteorologist, a person trained to study and forecast weather.

WHAT ARE THE TOOLS A METEOROLOGIST USES?

Construct weather instruments to be used to collect data. Use real weather instruments or pictures of weather instruments to explain how they are used. A meteorologist uses a thermometer, barometer, wind vane, anemometer, hygrometer, rain gauge, satellite pictures, and direct observation.

WHAT IS THE MOST IMPORTANT FACTOR CAUSING WEATHER?

Water vapor is the most important factor causing weather. It is largely responsible for clouds, rain, snow, hail, dew, frost, winds, and most other weather characteristics.

WHAT IS A CLOUD?

A cloud is condensed water vapor in the form of liquid or solid.

HOW ARE CLOUDS FORMED?

To make a cloud use a half or whole gallon clear glass container with a wide mouth opening. Obtain a balloon or piece of rubber sheeting large enough to cover opening. Place about 3 cm of water into the container. Place the smoking match into the container. Tightly secure the balloon or piece of rubber over the opening with a large rubber band. Gently but firmly press down on the covering to the count of 15. Pinch the covering and pull up as tightly as possible to the count of 15. Repeat several times. A cloud should form over the water when the pressure is decreased (on the upward pull). If a cloud can not be seen light another match and repeat the process of adding smoke to the jar.

Water vapor, which is invisible, needs a nucleus on which to condense. The smoke has provided the nuclei. Clouds are formed by water condensing on small particles in the air.

QUESTIONS FOR A RAINY DAY

Where does rain come from?

Are all drops the same size?

Do rain drops feel warm or cold?

Do rain drops fall a long way?

What happens to drops when they hit the ground?

Does it make a difference what surface they hit?

Is water running in the gutter clear or muddy?

What is the water running in the gutter carrying?

Why does it appear to be raining twice in a forest?

How many drops of water fall on a leaf? a tree? a forest?

Will all leaves receive the same number of rain drops? Why?

Where does water go?

How many rivers and lakes does it enter before it reaches the ocean?

Why does soil get soft after a rain?

Do earthworms need air?

Where do animals go in the rain?

Can you find a place that is dry during a rain?

How do mother birds keep babies in their nest dry?

WHAT IS HUMIDITY?

Place two tablespoons of cobalt chloride and one teaspoon of table salt in a cup of water. Dip pieces of white cloth in the solution. Hang up

to dry. Blue color indicates dry and clear weather, pink color indicates possible rain. This will keep a long time. Humidity is the water vapor in the air.

HOW DOES HUMIDITY AFFECT THE RATE OF EVAPORATION?

Use the same washcloth for each of the following experiments. On a wet day put a given amount of water on the washcloth and hang on a clothes line to dry. Record the time needed to dry. On a dry day put the same amount of water on the washcloth and hang on a clothes line to dry. Record the time needed to dry. The more moisture in the air, higher the humidity, the slower things dry because there is so little room in the air for more moisture.

WHAT IS WIND?

Two identical bottles, one filled with cold water and the other with hot. Add a drop of food coloring to the hot water. Invert the cold water bottle over the hot water. Observe what occurs when water of different temperatures is mixed. Wind and air have many of the same characteristics. Wind is a convection current. As air next to the earth is heated, it becomes lighter. The warm, lighter air is pushed up by colder, heavier air. As the colder air is heated, it becomes lighter and is pushed up by other colder air. The process continues until there is a steady flow of moving air called wind.

HOW IS THE EARTH HEATED UNEQUALLY?

Put the same amount of soil into two identical shoe boxes. On a sunny day place both boxes in the direct sunlight. Lay one box flat so that it receives rays slanted. Prop up the other box so the sun's rays strike it directly. Place thermometers into the soil of each box. Take the temperature readings every 10 minutes.

The earth is heated unequally due to the sun's rays striking different parts of the earth at different angles.

Fill identical cans with the same amount of light colored sand, dark soil, and water. Place in the full sunlight. Record temperature to start and every 15 minutes until they do not change. Place in the shade and continue to record the temperature. Different surfaces are heated unequally.

Wind is the movement of air set up by the unequal heating of the earth's surface by the sun.

WHAT IS THE WIND CHILL INDEX?

Read and record the temperature on three thermometers. Wet two pices of cloth and place over the bulb of two of the thermometers. Tie the cloth to the thermometers. Put one of the thermometers with the cloth on it in a plastic bag and close. Place the three thermometers close but not touching. Fan the three thermometers for two minutes, (an electric fan would be best). Record the temperature of each thermometer.

Obtain a wind chill chart. Wind cools down a wet surface faster than still air.

Because the earth does rotate, the movement of air over the earth becomes more complicated. Winds in the northern hemisphere are deflected to the right. Winds in the southern hemisphere are deflected to the left. A series of wind belts are produced, with the winds in each belt moving in a definite direction. The wind belts shift with the seasons because of the sun's rays striking the hemispheres differently.

WIND BELTS: Doldrums are an area of low pressure at the equator.

Horse latitudes are a belt of descending, high-pressure air, about one-third of the distance from the equator to the poles.

Trade winds are the winds flowing back to the equator.

Prevailing westerlies are winds that flow from the horse latitudes toward the poles.

Because of the earth's rotation there are the southwesterlies in the northern hemisphere and northwesterlies in the southern hemisphere.

Subpolar lows are at a little more than two-thirds of the distance from the equator to the poles. The warmer air that is still moving toward the poles is pushed up by the cold air moving down from the poles toward the equator. The upward movement of warm air produces low pressure.

Polar easterlies are at the poles where masses of cold air move down toward the equator.

Jet streams are a narrow band of high speed, 640km an hour, winds 8-16 km above the earth.

Monsoon is a seasonal wind that changes its direction in the summer and in the winter.

Land and sea breezes are created by the different temperatures of the land and water.

Mountain and valley breezes are created by the uneven heating of the air over the mountains and valleys.

RECORDS FROM GUINNESS

U.S. highest temperature: 134 degrees F. on July 10, 1913, in Death Valley, California.

U.S. longest dry spell: 767 days 1912 in Bagdad, California.

AUDREY H. BRAINARD *is an elementary science consultant at Georgian Court College in New Jersey.* □

WEATHER ACTIVITIES

Ned Black

MAKE A WEATHER CHART

Make a weather chart on a piece of paper or large oaktag. Record the weather each day for a week or longer. Discuss how weather affects our lives.

Date	Temperature	Humidity	Barometer	Precipitation	Cloud Cover	Wind

Graph your recordings designing specific graphs for your purposes.

WATCHING CLOUDS

Clouds are fun to watch! They are always changing and moving. Some clouds look like cotton puffs. These are cumulus clouds. Sometimes the sky is covered with sheets of low grey clouds. These are stratus clouds. Some clouds are very high and feathery. These are cirrus clouds.

Go outdoors for a while each day for a week. Look at the clouds and draw what you see. Do cloud shapes remind you of animals or faces? Do the clouds indicate anything about the weather?

NED BLACK *teaches at Oceanside Public Schools, Long Island, NY.*

GOOD READING

Sunshine Makes the Seasons and ***Hurricane Watch*** by Franklyn M. Branley, illustrated by Giulio Maestro, New York: Thomas Y. Crowell, 1985, 32 pp.

Sunshine Makes the Seasons, a revised edition of an earlier edition is brought up to date and is one of a series of many *Let's Read and Find Out* books. Like other books in the series it is set in large type with large drawings and diagrams. The explanations are clear and very helpful and many illustrations are full page and in color. The scientific concepts are carefully developed with no unnecessary vocabulary. There are many helpful diagrams. The author is a scientist and a talented science teacher.

Hurricane Watch (paper) is the same format, with the same type of illustrations. It describes the cause, origin and destruction caused by hurricanes. Considerable attention is given to how people prepare for these storms as well as how scientists try to forecast them. The art work is realistic and the book emphasizes the positive preparations for storms. A valuable contribution to this series.

Glenn O. Blough

Also by Franklyn Branley, ***Snow Is Falling,*** another read and find-out science book for 4 to 8 year old explorers illustrated in bright colors by Holly Keller. H.R.

Storm: A Novel. By George R. Stewart. 1983, c. 1941, 1947. Published by University of Nebraska Press. 901 N. 17 St., Lincoln, Neb. 68508. paperback, $8.95.

One of the principal classics of American meteorology is a novel, *Storm*. In the novel, a Junior Meteorologist working at the Weather Bureau in San Francisco spots a disturbance moving east over the Pacific, christens the storm Maria, and watches as the storm gathers force. The story switches back and forth among certain people under the storm, some just happening along and some with duties to save life, repair phone lines, or fly planes.

The late George R. Stewart, a Californian, took to the road to write this book, talking to highway patrolmen and experiencing what they went through whenever a bad storm swept in from the Pacific to flood the valleys with rain and lash the mountains with snow.

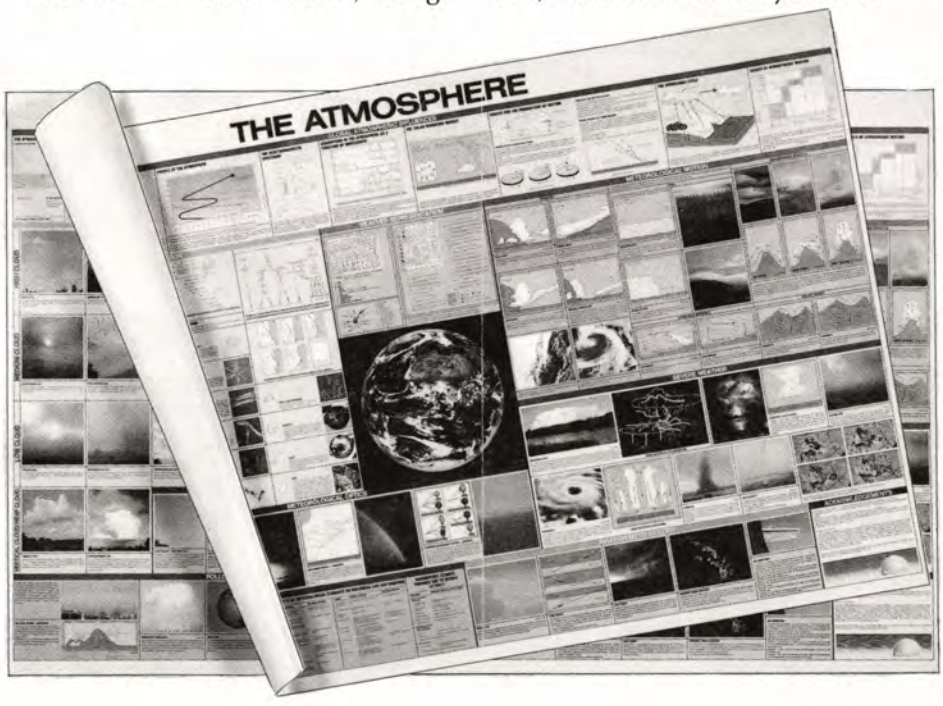
J.K.

THE ATMOSPHERE, Keith Foley, published by Geo-Science Resources, P.O. Box 2096, Burlington, NC 27126, $14.50.

If a picture is worth 10,000 words then this colorful 140x85cm. (55x33 inch) wall chart with its more than 80 pictures, diagrams, and charts is a small, easily understandable encyclopedia on weather. It contains color photographs and diagrams of clouds, frozen precipitation, fronts, storms, fog, and the hydrologic cycle. It also diagrams the effects of land masses, topography, oceans, urban areas, and pollution on weather. There is a section on meteorological optics: blue sky, halos, rainbows, and mirages. On more advanced levels it deals with aviation meteorology, the use of radar to document storms, along with primary circulation patterns of the air, profile of the atmosphere, the electro-magnetic spectrum, forces for the production of motion, and other physical science or physics concepts.

On the wall of a library, a classroom, a science lab or even a hall the pictures and easy-to-read labels of this chart could serve as a reference for observations, and for raising and answering questions for elementary grades while the smaller print and diagrams would provide up-to-the-minute information and develop understandings of the intricacies of Earth's weather with upper middle grade and secondary classes.

HELEN R. RUSSELL, *Science Consultant, Manhattan Country School.*



A Game of Catskill Nine-Pins*

A caravan of peaks
and mottled vales
splotched with scarlet
spread before me and
hold the echo of rolling
rocks for just a moment
awakening me to that
old nine-pin reality.

Richard F. Fleck

*See Washington Irving's "Rip Van Winkle"

NATURAL HISTORY OF VACANT LOTS by Mathew F. Vessel and Herbert H. Wong, drawings by Pamela Vesterby, California Natural History Guide No. 50, University of California Press, Berkeley. 1987 284pp.

It's interesting to reflect on the evolution of field guides. First we had guides to groups of living organisms (birds, mammals, ferns, wildflowers) and non-living things (rocks and minerals, stars and constellations). Then came field guides to biomes (forests, grassland, deserts, seashores) followed by guides to animal behavior and plant community relationships.

More recently field guides to backyards and human neighborhoods, and even the world of nature indoors (see *NATURE STUDY,* September 1987, p. 26) have appeared. These guides to nature close at hand are perhaps the most important and are certainly long overdue in appearing. Backyard field guides in the hands of young people can help stimulate an interest in the natural world. The rest of us can't be reminded too often that ecology is an immediate and intimate science and not only that of remote, pristine areas.

Although *Natural History of Vacant Lots* doesn't call itself a field guide, it is. It's non-technical, field guide-sized and has its flora and fauna organized in simple, easy to use form. Line drawings facilitate identification of plants and animals. I especially liked the several double-paged food web paintings that showed plants and animals in their natural setting. I wish the editor had chosen to include more of these paintings and had used color instead of black and white. Instead, 16 pages of nearly useless color and black and white photographs were included. Since the tiny photographs are neither an aid to identification nor show very clearly habitat relationships, I guess that their only justification for inclusion was the editor's notion that they would make the book more marketable. Fortunately this is the book's only real fault. Several chapters on vacant lots as ecosystems, including seasonal variations in disturbed areas, make for fascinating reading. Extensive lists of common species of disturbed urban areas keyed to California's major ecological communities is an excellent reference and checklist.

For me as a member of ANSS and a student of the history of nature study, the two-page Editorial Note and Dedication was of special interest. In it, Arthur C. Smith, General Editor of the California Natural History Guides, notes that this book is the 50th in a series devoted to the natural history of California and the West. When this series was begun in 1950, nearly all natural history books available to California schools were devoted mostly to eastern species. Mr. Smith recounts his own experience as a fifth grader assigned by his teacher to go and look for species that would have required a field trip east to Utah or Kansas to find. In 1966, Mr. Smith's son was given the same assignment from the same books written about eastern plants and animals! The idea for popular natural histories about California was inspired in the 1920's by two California professors who had done their graduate work at Cornell University where the publication of popular natural histories had long been a tradition. As a result, this book was dedicated to, among others, Cornell's E. Laurence Palmer. The author of many very popular natural histories, Dr. Palmer was president of ANSS in 1935-36.

Now that California is no longer the poor stepchild of the eastern publishing establishment, I hope *Natural History of Vacant Lots* will inspire as good a work about vacant lots back east.

Frank Knight

Earthen Wayfarer, by Richard F. Fleck. Writers House Press, Iowa City, IA, 1988. 40 pp. $7.95.

Here I sit looking out my dormer window
trying, in my mind, to preserve and freeze
a cluster of maple trees all gone yellow
swaying in each breeze coming off the mountain
and enclosing my consciousness with a leafiness
not soon to be forgotten, for both I and they,
with a frail pane in-between, metamorphose
bit by bit with each chill of autumn so keen.
But how foolish to assume maples are through
at season's end when, in reality, they too
face a hundred years or so of frosts and thaw
and sun and rain–long live mapledom's reign
where I, like they, cannot dare to feign
a constancy amid all this earthen change.

(IN THE MIDST OF MAPLEDOM by Richard Fleck)

Long-time readers of *Nature Study* may remember Richard Fleck's nature essays and reflections published 20 to 25 years ago. As a young ranger in the Rockies, and later during his treks in Ireland and on the Continent, his prose focused our minds on nature while touching our hearts with wonder. It was natural that he should move from prose to poetry: we published several of his poems which now appear in this and other collections.

Earthen Wayfarer is Fleck's fourth volume of poetry. It is organized in three parts: "Cottonwood Moon" deals with the American West and Indian themes; "Bamboo In The Sun" springs from his experiences in Japan as a visiting scholar; "Winter Harvest" contains 15 poems including the one printed above. Rich in imagery, Fleck's poetry reveals a sensitivity and rapport with non-human Nature which reflects favorably on his human nature.

He moves our thoughts from particular objects or events to the larger context in which these things have meaning; then we are surprised and delighted when our thoughts take off, as it were, soaring after universal truths. You'll enjoy the freeing effect of Fleck's free verse.

(J. A. Gustafson)

Protecting the Ozone Layer: What You Can Do; A Citizens' Guide to Reducing the Use of Ozone Depleting Chemicals. By Sarah L. Clark. Published by the Environmental Defense Fund, 257 Park Ave. South, New York, NY 10010. 32p. paperback, $2.00.

Harm is done to the protective ozone layer of the atmosphere by chlorofluorocarbons (CFCs) and halons. They release chlorine and bromine which destroy ozone in the stratosphere and let in untraviolet (UV) radiation. Increased amounts of UV cause more skin cancer, more cataracts, less effective human immune systems, and harm to crops and water systems.

A layer of slow-dissipating CFCs and halons remains in the atmosphere for decades, trapping earth's heat to create the "greenhouse effect" which could cause sea level rise and flood coastal regions.

Some damage has been done already. Some governments, local, national, and international, have taken some action against CFCs. The message of this clear, informative book is: Stop these harmful chemicals now!

To do this, the ordinary citizen can establish recycling centers for CFC reclamation; campaign for recovery of CFCs when refrigerators and automobiles are disposed of; promote better servicing standards for air conditioners and refrigerators; watch auto air conditioners for leaks and defective recharging; switch from rigid foam insulation to such alternatives as fiberglass in the home; stop using Halon-1211 in fire extinguishers; urge hospitals to substitute steam sterilization for ethylene/CFC sterilants; and limit and stop use of polystyrene foam products (such as drinking cups) and turn to paper products instead.

Affecting the entire world, this threat to the ozone could be the most urgent issue of our times, but people can do a lot to prevent its getting worse.

J.K.

Watching For the Wind: The Seen and Unseen Influences on Local Weather. By James G. Edinger (American Meteorological Society, Science Study Series). Published by Anchor Books, Doubleday & Co., New York, 1967. Illustrations by Kenneth E. Crook, Paperback.

In 1967 a Los Angeles meteorologist, pilot, and professor, wrote this book for amateur meteorologists, defining these as "people who glance at the sky before going on a picnic or heading for a baseball game."

As James Edinger describes winds blowing, air soaking up moisture from lakes or oceans, land forms that help or hinder the flow of air, cloud forms and how they change, his writing, mixing science with personal experience and using colorful analogies, is designed to appeal especially to high school readers.

For instance, he writes of a very strong, sudden wind in an Andean valley in terms of how his sons, getting out of their car, actually leaned on the wind, for the fun of it. When he gets to thermals, he says, "Cloudless updrafts set off by daytime heating of the ground are called thermals. Perhaps you have seen a hawk, wings motionless, circling up and up until he is but a speck in the sky. His airy spiral traces out with easy precision the dimensions of such a thermal. How the pilots of sailplanes envy his uncanny ability to seek out these completely invisible updrafts."

His chapter on the infamous Los Angeles smog does much to explain why the smog appears, but is not hopeful about an end to smog.

Like too many good books these days, this is out of print, but it should be possible to find copies in fair-sized public libraries.

Jessie Kitching

Understanding Our Atmospheric Environment; 2nd ed. By Morris Neiburger, James G. Edinger, and William D. Bonner. Published by W. H. Freeman & Co., 4419 West 1980, South, Salt Lake City, UT 84104. 1982. 462 pages. $25.95.

The authors believe that the saying, "Nobody does anything about the weather" is "never completely true." They are shedding light on weather processes and on weather prediction, and doing so in clear, not too technical English. They conceived this book as an elementary textbook dealing mostly with the weather processes in the lower part of the earth's atmosphere. Revision for this second edition has taken account of much reader reaction. The result, while not a simple, easy book, is a rational, college-level treatment.

The authors cover radiation through the atmosphere; clouds; the gas laws; convection; global circulation of the atmosphere; storms; tropical weather; and forecasting. Weather instruments and their use are explained. Photos, graphs, diagrams, and maps are liberally provided.

Among the most interesting features: recent weather reports by satellites; description of causes and a black-and-white picture of the *aurora borealis* or Northern Lights; explanation of fog formation; review of seasonal fronts and the resulting weather; and newest knowledge about jet streams.

Of major importance is a chapter on kinds of air pollution, their severity and spread (especially acid rain), their effect on human health, and controls that would reduce emissions at the source.

A bibliography, a glossary, a list of acronyms, and a good index are included. Knowledge of mathematics would be a help for some sections of the book, but much can be understood without more than elementary math.

J.K.

Raindrop

Verne Rockcastle

A raindrop splashed upon the sill,
Another on the pane.
A child looked, frowning, at the drop
That cancelled out his game.

But I, I saw beyond the drop
And saw a world in motion:
The drop, minute, was part indeed
Of river, lake, and ocean.

I saw the sun that drew it up
From the surface of the sea;
I felt the wrath of mighty storms
Brewed from its energy.

I saw the many living things
That drop helps to sustain;
I saw the vapor it once was
Before it fell as rain.

All this, and more, before me flashed
When on my sill a raindrop splashed.

CLOSE ENCOUNTERS WITH INSECTS AND SPIDERS, written and illustrated by James B. Nardi, Iowa State University Press/Ames, 185pp. (6½x9)

A good sample of text and contents of *Close Encounters with Insects and Spiders* happens if you open to page 99 at "Leaf Chewers." "Inchworms slink along by drawing their posterior ends up to their front legs (Fig. 3.43). In this way the back end keeps pace with the front end, and the body segments in between form a loop that straightens as the front end inches forward".... "You can encounter inchworms in many places and in many forms. One of them might just plump down on your arms and begin pacing off the distance between your wrist and elbow!" The drawing on the page shows the loop in careful detail accompanied by a scale to indicate size. This text and drawing are typical of the whole text.

The opening introductory section of the book introduces the reader to an understanding of arthropods: their likenesses and differences, names, numbers, outer structure, sizes and classification. From then on we meet the animals in various environments: 1) Home, School, and Garden; 2) Ponds and Streams; 3) Meadows and Fields; 4) Trees and Logs; and 5) Beneath Our Feet. The text is clearly written, informative, well organized and descriptive. The drawing sizes are indicated in excellent detail for use in identification. Altogether this is an excellent field guide to insects and spiders.

Glenn O. Blough

BOOK REVIEW

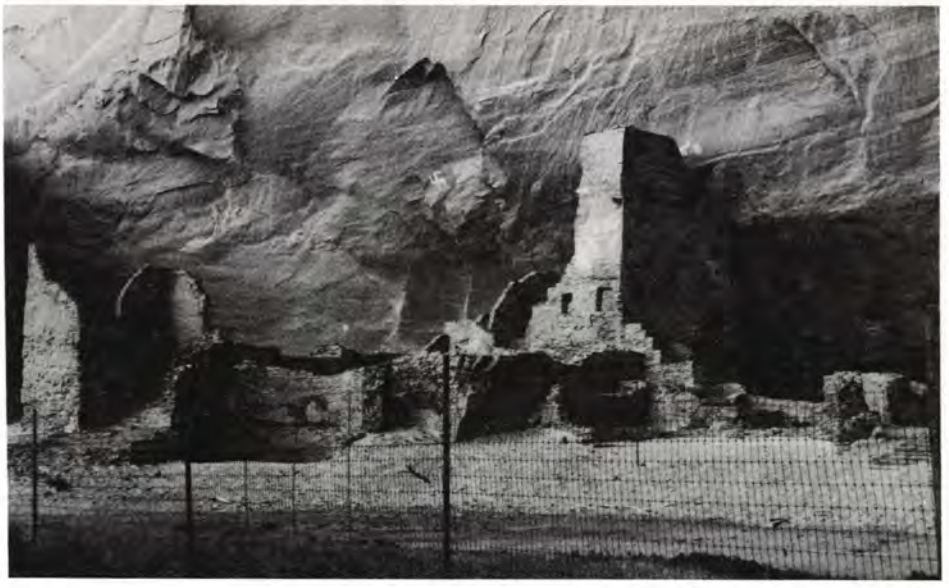
Mary Colter: Builder Upon the Red Earth by Virginia L. Grattan, Northland Press, Flagstaff, AZ, 1980.

The role of the architect is to accommodate human needs in harmony with the environment. The work of Mary Elizabeth Jane Colter, an American architect in the late-19th to mid-20th century, typifies an architecture in harmony with the land.

Colter's architecture grew out of the land and the richness of its history. Her buildings pay homage to the early inhabitants of the Southwest. Perhaps the best surviving examples of her work remain along the south rim of the Grand Canyon. Native Americans had inhabited the land for a millennium and had built upon it with materials at hand, creating dwellings in harmony with the environment. Colter's buildings had their roots in the history of the land. She built ancient looking Indian "ruins" at the Grand Canyon–the Watchtower and the Lookout–after the authentic ruins of Indian towers and dwellings found in the Southwest.

Colter's buildings have a simplicity of the early architecture after which they were patterned. There is a charm and dignity in her buildings. Like other architects in California and the South-

Photos by Helen Ross Russell



PLEASE DO NOT USE HELIUM FILLED BALLOONS FOR WIND STUDIES. UNTOLD NUMBERS OF MARINE ANIMALS, PARTICULARLY MAMMALS, DIE EACH YEAR BECAUSE THEY SWALLOW THE BRIGHT BALLOONS THAT DRIFT OUT TO SEA.

west just before the turn of the century, Mary Colter was more interested in rediscovering the cultural heritage of the region than imitating European style. Her buildings fit the setting because they grew out of the history of the land.

A school teacher in St. Paul, Minnesota, Mary Colter became an architect, designer and decorator for the Fred Harvey Company from 1902 to 1948. The Grand Canyon remains the showplace for this singular woman's architecture. Richly illustrated with photographs of her works in progress and completed, this book provides many delightful insights into this trailblazing woman's effort to bring an architecture of harmony to the Southwest. The book provides a wonderful object lesson in how architecture can help us live in harmony with the environment.

ALAN R. SANDLER, *Director, Education Programs, The American Institute of Architects.* □

Nature Discovery II – The Mammals' World. Massachusetts Audubon Society. Nature Discovery Press. 266 A Harvard Street, Suite 1, Cambridge, MA 02139. 1988. 64pp. $7.45 (4-8).

The Mammals' World, the second in a series, provides information on common mammals, their anatomy and physiology, ecosystems, and a four page section on identifying mammals by signs in the environment. The text is augmented by excellent black and white illustrations. This workbook is intended for children in grades 4-8 working independently. An activity poster and puzzle, "Tracking N. E. Mammals" is provided for children in grades K-6.

The program is advertised as having "exciting hands-on projects that promote active investigation and creative problem-solving." The program is, however, substantially a reading workbook with students obtaining information from the text and answering questions about the text. In some topics, the students do make graphs, complete chipmunk burrow drawings, or examine and make inferences based on examination of illustrations of teeth. Yet, all the work is paper and pencil – not hands-on! The first time an activity relates directly to an outdoor excursion is in the last four pages of the book.

The *Teacher Guide to Activities* which accompanies the text suggests that the optimum presentation of this material is as a self-directed guide. *The Mammals' World,* is not entirely suitable as a self-directed guide. The reading level is well above the 4-6 grade range and the complexity of the format would prove difficult for many junior high school students. The learning strategy in some areas is based on discussing responses to questions. This structure would require teacher direction.

There is a wealth of excellent material in *The Mammals' World* which would be useful as background and resource material for the teacher. The teacher's guide needs expansion and would be enhanced if it included directions for implementing teaching strategies other than the self-directed guide.

Reviewed by **SANDRA FLYNN BURNS,** *Professor of Science Education at Central Connecticut State University, New Britain, Connecticut.* □

A LOST BOOK – SONG OF THE SKY

Jessie Kitching

[Editor's note: There are many worthwhile books which were published years ago and which are no longer in print. Most are available in libraries, however, and it is the objective of this new column to drawn our readers' attention to them.]

In 1954, a navigator-scientist named Guy Murchie published an aviator's book of the weather, *Song of the Sky; An Exploration of the Ocean of Air* (Houghton Mifflin). This 447-page book, which takes a poetic yet practical approach to weather as experienced both by pilots and by people on the ground, is illustrated by the author's many small drawings and diagrams. Feathers, birds, dragonflies, airplanes, propellers, balloons float on the pages. Diagrams show, among other processes, the formation of thunderstorms, the waves of air above mountains, the patterns of cities and countryside seen from a plane, the air flows in a tornado.

The book won the John Burroughs medal for the best nature book, 1955. It is unfortunately out of print but is available in many libraries. Its tone, scope, and interest can be sensed from the following extracts, printed by permission of the author.

About rainbows:

"Big [rain] drops (.04-.10 inches diameter) make predominantly red rainbows with bright violet and green lines but faint blue; smaller drops produce less red; very small drops (.002 inches) make a rainbow with a distinct white stripe."

About animals' insulation:

"Animal fur and fat serve as natural blankets for arctic animals, keeping their body heat in. But the smaller the animal the thinner the insulation it is able to carry."

About thunderbolts:

"Small houses are sometimes completely shattered by a thunderbolt, as great trees or chimneys are split by the explosive expansion of the extreme heat, but I heard of one house that was saved by the same lightning that set it afire. After passing through the building and igniting some woodwork, this bolt with a conscience 'leaped to a near by fire-alarm box, set it off, and summoned the engines'!"

About hailstorms:

"A few years ago a . . . plane suffered more than ten thousand dollars worth of damage while flying in clear air within half a mile of a large thundercloud. The pilot had not thought the great white anvil soaring innocently high above his wing tip could endanger him so long as he kept well clear of the actual cloud, but the beautiful canopy and its scarflike fringe had already dispatched a barrage of invisible heavy hail which struck him out of the blue like a volley of golf balls, denting the wings and fuselage so seriously that half the duralumin skin of the airplane had to be replaced."

About frostbite:

"Frostbite is among the first of arctic dangers, especially to the nose. I froze

my nose once when it was more than 60 degrees F. below zero in Siberia so I know the discomfort of having a nose swollen to twice normal size with the skin peeling off like an onion. The Air Lines War Training Institute manual advises that when you find any frozen place on your skin you should take off a glove and press your bare hand to the white, stiff flesh. This will thaw it just enough. The book strongly warns against rubbing a frozen spot, or using snow on it, for that is likely to bruise the brittle frozen skin, leaving a path for infection."

Murchie has been a war correspondent in Europe 1940-42; a navigation instructor, 1943-43; a trans-oceanic navigator, 1944 and again in 1951-52; a teacher; and the author of several other books.

He now lives in retirement in California. From there he recently wrote *Nature Study* of his concern for earth's ecology: "The destruction of forest on Earth, now going on in places like Brazil, is a serious danger not only to our planet's weather but, if it isn't controlled soon, it could drastically reduce the quality of life for us all. □

THE EIGHT MOST CRITICAL ENVIRONMENTAL ISSUES OF 1989

As listed by the Environmental Defense Fund

With the greenhouse effect frequently in the headlines, it is clear that environmental concerns are relevant to any consideration of the earth's weather. Global warming of three to eight degrees Fahrenheit is expected to alter climatic patterns and increase sea levels in the next century. Although scientists vary in their assessment of the magnitude and speed of these changes, the trend is clearly established.

The Environmental Defense Fund has published its agenda for the coming year. It emphasizes positive actions, stressing creative alternate policies which meet societal needs, while protecting the environment through legal means.

For further information, contact them at 257 Park Avenue South, New York, NY 10010.

B.J.

THE GREENHOUSE EFFECT

Action for 1989: Working toward a comprehensive international accord to (a) drastically cut emissions of the most damaging gases; (b) stop the destruction of tropical rainforests; and (c) cut inefficient use of fossil fuels.

OCEAN POLLUTION

Action for 1989: Make sure the MARPOL Treaty, which prohibits dumping of plastics at sea, gets enforced internationally. Reduce pollutants from air, water and land flowing into the oceans. End the use of shellfish-killing TBT paint on boat hulls.

PROTECTING WILDLIFE AND HABITAT

Action for 1989: Step up campaigns to save endangered sea turtles, to stop the killing of porpoises by the tuna industry, and to protect penguins and seals in the Antarctic. Press for strong enforcement of the Endangered Species Act. Preserve tropical rainforest habitats of many of the world's endangered species.

RECYCLING

Action for 1989: Build public support for recycling with up to $25 million in donated advertising. Educate municipalities about the economic advantages of recycling over landfilling and incineration. Expand the markets for recycled materials.

SAVING THE RAINFORESTS

Action for 1989: Pressure the World Bank and other development banks to make sure their investments conserve the rainforest. Promote modernization of inefficient power delivery systems as an alternative to building proposed large-scale dams that would cause tropical forests to be flooded or cut down.

ACID RAIN

Action for 1989: Push for a national law in the next Congress to limit pollution from power plants and smelters. In the meantime, push for enforcement of state standards, many of which EDF helped to develop. Work toward international agreements to stop acid rain. Continue to research, monitor and expose the damage that acid rain is doing, not just to forests, lakes, and streams but to ocean life as well.

ANTARCTICA

Action for 1989: Lay the groundwork to make sure the 1991 international treaty governing Antarctica includes conservation. Make sure it safeguards penguins, seals and other wildlife vulnerable to oil spills and pollution. Demand clean-up of toxic waste dumps on the continent and of pollution in Antarctic waters.

TOXICS

Action for 1989: Press for safer paper production methods to get dioxin out of paper towels, plates and other bleached paper products. Work for better control of leaking underground toxic storage tanks. Get lead out of old plumbing to protect drinking water. Stress source reduction: not just cleaning up toxics, but preventing them from ever reaching the environment. □

Long-time ANSS member, Dr. Arthur Nelson, died on December 18, 1988. Art graduated from Cornell in 1949. He was one of the group of E.L. Palmer's doctoral candidates who did a research study on conservation education in the United States under a Pack Foundation grant.

As a Californian, he conducted the research on junior colleges—what was going on in the conservation field and what could be developed. At the time the junior college movement was young and almost entirely concentrated in California. After graduation he returned to his native state to teach and was active in western environmental programs including working with Stan and Dodie Mulaik when special western programs were being conducted by ANSS. He participated in the last ANSS/AAAS Christmas program which was held in San Francisco in 1975. In recent years Art's professional activities had been curtailed because of his loving care of his wife, Karen, who has been totally handicapped by arthritis.

Winter in Solid State

Verne Rockcastle

Winter assails us in flakes:
It puts a lid on our lakes
To skate.

O'er the ice, you can thank it
For laying a white blanket
To ski.

For those less objective,
It calls forth invective
To utter.

But for those who can stand
In the snow and abandon their putter,

Winter in solid state
Is great!

ECOLOGY AND A PIONEER WOMAN

Martha E. Munzer

Ecology—I personally had never come across the word until 1952, even though I'd been trained at a top flight scientific institution thirty years earlier.

It was at this same technical school—MIT—that the very first woman was admitted "only as an experiment" in 1871. Her name was Ellen Swallow, later to become Ellen Swallow Richards.

Her early love of the outdoors had provided her with intimate knowledge of rocks, fossils, soil, plant and animal life. Water, essential to all living things, was of particular concern to her.

In 1893, while Ellen was doing water studies at MIT from a chemical and physical viewpoint, a German scientist, Ernst Haeckel, was investigating the environment from a biological point of view. His new approach to the environment he called "Oekologie." Tracing the word to its Greek origin, Ellen found that "oek" meant every man's house and that "logie" referred to knowledge of that universal home. Therefore, the science of "Oekologie" had of necessity to encompass the total environment. To give the widest possible meaning to the term, Ellen added mineralogy and earth science to her water studies.

This pioneer woman died in 1911 after an amazing career in which she created and traversed many completely new pathways. In her later years, she began the study of the relationship of human beings to their environment not only physically, but socially as well. She endeavored to explain how the poor quality of the physical environment is related to a poor social habitat.

Ellen Swallow Richards was a person far ahead of her time. Few know that her abiding interest in "Oekologie" led directly to the gradual acceptance of ecology as a science, its application more and more appreciated as the very basis for keeping our endangered planet a living one.

At my sixty-fifth class reunion, at our common Alma Mater, I was pleased to discover how vigorously environmental studies are being integrated into the curriculucm. What an appropriate memorial to MIT's first female student, the one who originally lent her best efforts to acquaint us with the term and the signficance of the word ecology.

Material in this article is to be found in an essay written by Gertrude Fox in an informal quarterly (Vol. III, No. 4) called "Ecospirit."

NEWS FROM THE ALLIANCE

Diane Wiessinger

Many of ANSS's members have ties to other environmental and education organization; many of us do not. For those of us seeking more information about environmental goings on, there is a wonderful group called the Alliance for Environmental Education. Its affiliate groups are as diverse as the Boy Scouts of America and Zero Population Growth, Inc., the American Forest Council and the United Auto Workers, Massachusetts Audubon Society and the California Association for Environmental and Outdoor Education. (Yes, ANSS is an affiliate, too.)

The Alliance publishes a quarterly newsletter, the Alliance Exchange, with 12 pages of conference dates, addresses for educational materials, legislation updates, research reports, and more. The following items are excerpted from the Fall '88 and Winter '88/'89 Alliance Exchange issues. If you or your organization would like to become a subscriber, send $5 (made out to the Alliance for Environmental Education) to Alliance Exchange, Box 1040, 3421 M St., N.W., Washington, D.C. 20007.

* The National Wildlife Federation provides current information on environmental bills before Congress, updated twice weekly. Call (202) 797-6655 for the recorded message.

* For $20/year you can become a "citizen scientist" and contribute your monthly rain pH measurements to North America's acid rain data pool. Contact the National Audubon Society, Citizens' Acid Rain Monitoring Network, 950 Third Ave., New York, NY 10022.

* The Worldwatch Institute has just published its fifth annual assessment of the earth's health. Each year, the publication pulls together information from many sources on populations, natural systems, resources, and global economy. For this year's edition, send $9.95 to Worldwatch Institute, 1776 Massachusetts Ave. NW, Washington, DC 20036.

* And finally, Duane Kelly, of the American Federation of Teachers, urges us all to write to our local school board and superintendent, to our state department of education, and to the U.S. Department of Education, in care of the White House. Says Kelly, "The philosophy that sets up school programs . . . simply does not include teaching that the supporting context for life and human society is a finite biosphere . . . Several million letters asking for a genuine quality environment program in U.S. education would be really hard for the educational establishment to disregard! Pie in the sky? If Coca Cola got over two million unsolicited letters when they tried to change the 'classic' Coke formula, how unreasonable is it to expect a response of similar magnitude for the sake of the biosphere?" Mr. Bush, you'd better get a bigger mailbox!

Letter to the Editor

Dear Helen,

I just wanted to tell you how much I enjoy the *Nature Study* publication. It is the top of my list of natural history magazines and I have taken them all at different times. I am 80 years old and have been involved in all kinds of natural history study with many groups; too numerous to list here.

Since I am coordinator of the South Central Ohio Preservation Society, Inc., I have tried to unite Natural and Cultural History. I do not think they can be separated. In fact, when I was asked to be the first president of SCOPS I said they would have to unite these two areas before I would accept the position.

Later when I was on the Advisory Board of the National Trust, I tried to get James Biddle to do the same with the National Trust and they have sometimes included it in their work. Many private gardens have wild plants and this past year I was made Chairman of Conservation in the D.A.R. and I suggested that they set aside a small plot in their gardens for natural plants and then list or just enjoy what happens. It is such a surprise to see what comes up. Even if you do not know their name it is fun to watch. I used to know a lot of the natural plants that I have forgotten in my old age.

When I was State Chair of Junior Garden Clubs we organized a Nature Study Weekend for the leaders and then asked them to go back to their counties and do the same with the Juniors. Following this I directed Nature Study Camp for the Ohio Association of Garden Clubs for four years.

I have been a member of Interpretive Naturalists, Brooks Bird Club, and various nature clubs around Ohio.

It does my heart good to read a publication like your last *Nature Study.* I have a daughter and a granddaughter who are teachers and I told them about your work for teachers.

We are listing some areas for the National Register and are listing the gardens, the wild plants and the effect that the Teays River and the glacier had on the gardens in this area. In one garden we have the Southern Magnolia, Canadian Hemlock, lilies, and Ginkgo trees and whole gardens of wild plants. How can this be left out of a nomination?

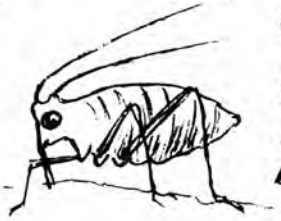
Helen Vanmeter
South Central Ohio
Preservation Society

Naturalist's Notebook

What Were These Things Made For?




This habit of looking first at what we call the beauty of objects is closely associated with the old conceit that everything is made to please man: man is only demanding his own. It is true that everything is man's because he may use it or enjoy it, but not because it was designed and "made" for "him" in the beginning. This notion that all things were made for man's special pleasure is colossal self-assurance. It has none of the humility of the psalmist, who exclaimed, "What is man, that thou art mindful of him"?




"What were these things made for, then?" asked my friend. Just for themselves! Each thing lives for itself and its kind, and to live is worth the effort of living for man or bug. But there are more homely reasons for thinking that things were not made for man alone. There was logic in the farmer's retort to the good man who told him that roses were made to make man happy. "No, they wa'n't," said the farmer, "or they wouldn't a had prickers." A teacher asked me what snakes are good for. Of course there is but one answer: they are good to be snakes.



"The Nature Study Idea"
L.H. Bailey



Adirondack Mist

Mist flanks the peninsulas
and points of land
far across those glassy waters
where dark pines
stand like flags above white birch
silhouetting the moon
shimmering in the wake of a loon.

Richard F. Fleck

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