Department of the Interior
NATIONAL PARK SERVICE
Yellowstone National Park

RANGER NATURALISTS MANUAL
of
YELLOWSTONE NATIONAL PARK

No. 24

1927

DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
YELLOWSTONE NATIONAL PARK
YELLOWSTONE PARK, WYO.

OFFICE OF THE SUPERINTENDENT

July 6, 1927.

Mr. Robert H. Dolliver,
Old Faithful Ranger Station,
Yellowstone Park, Wyoming.

Dear Mr. Dolliver:

You are already familiar with the Ranger Naturalists Manual for Yellowstone National Park.

In view of your contribution to this manual, I am sending you herewith copy No. 24 for your personal use.

Sincerely yours,

Horace M. Albright
Superintendent

Department of the Interior
National Park Service
Yellowstone National Park
Yellowstone Park, Wyoming. June 1, 1927

Horace M. Albright,
Asst. Director (Field)
National Park Service;
Superintendent.

Sam T. Woodring,
Chief Ranger.

J. E. Haynes,
Act. Director of Museum.

Edmund J. Sawyer,
Park Naturalist.

RANGER NATURALISTS MANUAL
of
YELLOWSTONE NATIONAL PARK

Dedicated to the Memory of

CHARLES PHILLIPS
1890 - 1927
Ranger - Writer - Scientist

A collection of articles pertaining to Yellowstone National Park written by various authorities especially for this manual. The first edition (1926) was published in typewritten form of which there were 12 copies. This the second edition (1927) numbers 125 copies.

PROPERTY OF -

U.S. NATIONAL PARK SERVICE MUSEUM

Please return this copy to the Park Superintendent at the close of the season.

No. 24

PREFACE

RANGER NATURALISTS MANUAL
of
YELLOWSTONE NATIONAL PARK

This collection of various lectures, guide-talks and special articles pertaining to Yellowstone National Park, it is hoped will be of real value to those assigned to guiding, lecturing, information and museum duty, in avoiding conflicting statements and too much repetition, also in getting efficient service under way promptly at the beginning of the season.

In the past a criticism has been made that some rangers occassionally "talk down" to their listeners and unintentionally give the impression that they think themselves superior to their audiences, but, as a whole, they have done their work in such an admirable way as to be a real credit to the National Park Service and to themselves.

We have a two-fold mission. We represent the Secretary of the Interior and the National Park Service as hosts to the People of the World. Each tourist is our personal guest. We are the faculty of the biggest summer school of nature study on earth, - a school of 200,000 pupils! Our glorious task is, in John Muir's words, "To entice people to look at Nature's loveliness". Our statements must be exact and cautious beyond possibility of question. And we mustn't hesitate to show our boundless delight in the marvelous and beautiful world we have to interpret.

This compilation is the result of a great amount of work of many strong friends of the Yellowstone, and many present and former members of the staff, and while it is only a start, we feel that it is suggestive of the possibilities of the important task of acquainting guests with the history, the science and the beauties of Yellowstone National Park, of which they and we are the owners.

Much other literature on the Park is available; and the cooperation of the other members of the staff may be had for the asking, in solving any problems that may arise in the work.

Your cooperation is solicited in contributing one or more articles for the amplification of this collection, and in suggesting improvements, which will be greatly appreciated.

Horace M. Albright,
Superintendent.

TABLE OF CONTENTS

The National Park Service, National Aspects, by Hon. Stephen T. Mather.....1
The National Park Service in Yellowstone National Park,
by Superintendent H. M. Albright.....2
The Responsibility of Federal and State Governments for
Recreation, by Dr. John C. Merriam 3
The National Park Service, by Marguerite Lindsley.....4
The History of Yellowstone National Park, by Ansel F. Hall.....8
The Discovery of the Yellowstone, by Robert H. Dolliver.....11
Fragmentary Evidence of the Presence of Early
Visitors to the Park Region, by Ansel F. Hall.....17
The Raynold's Expedition, by Ansel F. Hall.....20
The Folsom Cook Expedition (1869), by Ansel F. Hall.....22
U. S. Geological Survey of Montana, Idaho, Wyoming
and Utah, 1871, by Ansel F. Hall.....24
U. S. Geological Survey of a portion of the Territories of
Montana, Idaho, Wyoming and Utah, 1872, by Ansel F. Hall.....25
First Ascent of the Grand Teton by White Men, by Ansel F. Hall.....28
Truman C. Everts, by Ansel F. Hall.....30
The Indians of the Yellowstone Country, by Charles Phillips.....32
Chief Joseph and the Nez Perce War, by Charles Phillips.....39
The Genesis of Yellowstone National Park, by Frank Thone, Ph. D.....48
Natural History of Yellowstone National Park, by Ansel F. Hall.....51
The Geological History of Yellowstone National Park, by Gerrit Demink.....52
Volcanic Activity in the Yellowstone Region, by Ansel F. Hall.....55
Ancient Geyser Basin in Cross Section, by J. E. Haynes.....56
Thermal Deposition in Yellowstone National Park, by J. E. Haynes.....57
Life Zones of Yellowstone Park, by Charles Phillips.....59
Table of Surface Temperatures of Hot Springs and Fumaroles,
by Dr. Arthur L. Day and Dr. E. T. Allen.....68
Table of Boiling Points of Pure Water, etc.,
by Dr. Arthur L. Day and Dr. E. T. Allen.....70
Water Analyses of Apollinaris Spring, Dedolph Spring and
Iron Spring (Gibbon Canyon), by Richard R. Brady, M. D.....71
Precise Elevations - Yellowstone National Park,
by U. S. Coast and Geodetic Survey of 1923.....72
Animals of Yellowstone National Park, Listing Names Given the
Males, Females and Young, by Marguerite Lindsley.....75
Animals of Yellowstone National Park, Listing Singular and
Plural Forms of Names, by Marguerite Lindsley.....77
Antlered or Otherwise Horned Animals of Yellowstone Park,
by Marguerite Lindsley.....78
Census of the Wild Animals of Yellowstone National Park,
by Sam T. Woodring.....79
Predatory Animals of Yellowstone National Park, by Marguerite Lindsley.....80
Yellowstone Park Bears, by Elmer A. Kell, Jr.....82
Review of the Bird Life of Yellowstone National Park,
by Edmund J. Sawyer.....85
Some Yellowstone Park Birds, by Dr. H. S. Conard.....90
Yellowstone Park Algae, by Marguerite Lindsley.....96
Flora of Yellowstone National Park (Tabulation) by Dr. H. S. Conard.....99
Trees of Yellowstone Park, by Herma Albertson.....105
Guide Lecture for Mammoth Formations, by Marguerite Lindsley.....112
Four Mile Nature Study Hike at Mammoth Hot Springs, by Dorr Yeager.....116
Electric Peak, by Ansel F. Hall.....120
The Norris Road, by Charles Phillips.....121
The Norris Geyser Basin, by Charles Phillips.....123
The Lower Geyser Basin, by Charles Phillips.....129
The Upper Geyser Basin, by Charles Phillips.....135
Morning Lecture, Old Faithful, by James D. Landsdowne.....147
Afternoon Lecture at Old Faithful Formations, by James D. Landsdowne.....152
Evening Lecture at Old Faithful Camp, by James D. Landsdowne.....155
History of the Yellowstone Lake, by Charles Phillips.....157
Address to Newcomers at Camp Roosevelt, by Dr. H. S. Conard.....159
Address to Newcomers at Camp Roosevelt (Longer Talk), by Dr. H. S. Conard..162
Notes on the Fossil Plants in the Region of Camp Roosevelt,
by Dr. Ralph W. Chaney.....164
Reading Up On the Yellowstone, by Francis P. Farquhar.....166

THE NATIONAL PARK SERVICE, NATIONAL ASPECTS.

By Stephen T. Mather,
Director, National Park Service.

The National Park Service, which celebrated its tenth birthday in 1926, is not only one of the youngest, but one of the busiest Government Bureaus.

In addition to administering 19 national parks, scattered from far off Hawaii to the coast of Maine, and from Alaska to southern California and Arizona, there are 32 national monuments to be protected.

Many scientific and technical problems are involved in addition to the wealth of administrative and fiscal details that require constant attention.

The principal functions of the National Park Service are to preserve these areas in as nearly as possible, their natural condition, and at the same time to make them accessible to the people for study, for recreation and for play.

This involves a nicely balanced policy of conservation, with the development of public utilities such as hotels, camps and transportation systems.

One of the first considerations in making the park accessible, is the construction of adequate roads and trails, to bear the concentrated traffic from a number of good approach highways. To insure their construction in accordance with the best engineering practices, the cooperation of the Bureau of Public Roads has been enlisted on the major road projects. The National Park Service has its own staff of civil engineers to maintain park roads, construct trails and handle many local engineering problems.

Serious landscape problems are involved, as the Service will not tolerate sacrificing scenic features to expediency in road construction, or in the placing of the various buildings of the public utility operators, or those of the Government itself.

Last year over two million people visited the national parks and monuments, and still more are expected in 1927.

To provide comfortable accomodations for all of these people, guard their health, protect them from accident, furnish them entertainment and educational facilities, and at the same time to protect the natural beauty of the parks and objects of scientific, historic, or prehistoric interest in these reservations is a big job. The success that this bureau has enjoyed is due in no small part to the cooperation that our tactful and efficient field forces have secured from the visiting public.

THE NATIONAL PARK SERVICE IN YELLOWSTONE NATIONAL PARK

By Horace M. Albright,
Superintendent, Yellowstone National Park.

Yellowstone National Park is the first reservation of its kind to be established in the world. It is the forerunner of the great national park system of the United States. Foreign countries have copied the national park idea given to the world by the Yellowstone Park Dedication Act, and now there are national parks on nearly every continent. King Albert National Park in the mountains of the Belgian Congo established to protect its abundant wild life, particularly the gorilla, is one of the latest and biggest parks to be established in foreign lands, and the first in Africa. It is somewhat smaller than Yellowstone but its management is similar.

The Yellowstone, a great wilderness containing 3,348 square miles, lying astride of the continental divide in northwestern Wyoming, and overlapping into Montana and Idaho, is a magnificent bit of old America. A thin thread of roads make its most important features accessible; but to see it thoroly one must ride its thousands of trails, those paths thru the forests and over mountain passes not originally blazed with human hands, but first marked in the soil and rocks by countless thousands of elk, deer, mountain sheep, buffaloes, moose and bears.

More than eighty percent of the area is heavily forested. Its many lakes and streams send their waters to both oceans. The Indians called it the "Land of Many Waters." The chief duty of the administration of the park is to protect its wild life, forests and marvelous exhibitions of Nature's special handiwork. This is done with 31 permanent rangers, 4 buffalo keepers, and 52 temporary rangers employed only during the summer when the public visits the region. Seven great camping grounds for the public have been highly developed with water and sewer systems, comfort stations, garbage disposal facilities, tables, wood and other conveniences. These are used by upwards of 100,000 campers each year, many of whom spend their entire vacations in the park.

Visitors who come by railroads to the various entrances, are cared for in the hotels and lodges, and they tour the park via the very efficient bus line. Picture and curio shops, stores and other enterprises are operated for the benefit of all travelers. All of these public utilities are operated under franchises from the Government, and are closely supervised in the public interest. There is scarcely a vacation need that cannot be met in the wilds of the Yellowstone.

The National Park Service also has the task of maintaining in Yellowstone National Park, 356 miles of roads, nearly a thousand miles of trails, 360 miles of telephone circuits, several hay ranches on which hay is raised for winter feeding of the buffaloes and other animals; properties which, with the exception of the road system, have been recently developed, or rebuilt. Even the road system is undergoing extensive reconstruction. Nature study, ranger naturalist service and museum development, to make the tour of the park more enjoyable and beneficial, is meeting with great success. Interpretation of the park's wonders, and the story of Nature's building of the park region are proving to be most interesting alike to young and old.

All the service to the public in Yellowstone National Park is based on the fact that the park belongs to the people, and that when they come here, they are entitled to friendly, courteous and kindly assistance. The park management eagerly awaits the opportunity to entertain the vast throngs of happy vacationists who will come this year. There should be no resisting the Call of the Yellowstone.

THE RESPONSIBILITY OF FEDERAL AND STATE GOVERNMENTS FOR RECREATION

Remarks at the National Conference of Outdoor Recreation, Washington, D. C., January 20, 1926.

By Dr. John C. Merriam,
President, Carnegie Institution of
Washington, D. C.

There are probably few aspects of normal life more distinctly personal than recreation.

Recreation as understood in this discussion is not easy to define. It is been probably to consider it as representing outdoor recreation for the purpose of rest, and of both physical and spiritual exercise of the type that builds up and strengthens.

Responsibilities of the Government (Federal) for contributing to meet needs of the people for outdoor recreation are assumed at present mainly thru two agencies; National Parks and National Forests.

National Parks have been established thus far almost entirely from public domain for the purpose of protecting and administering for use of the people, areas containing exceptional natural features with sufficient surrounding territory to preserve their primitive characters unimpaired. The purpose of use and enjoyment in the highest recreational sense has been prominent in definition of their functions. The element of magnitude such as would permit undisturbed appreciation of these wonders has also been recognized in fixing wide boundaries.

The recreational uses of national forest and national park reservations will unavoidably overlap in some respects. In the case of the forests the areas will be kept protected first because of economic value; in the case of the parks, general recreational, educational, and aesthetic uses have furnished the reasons for existence.

The National Parks are commonly considered as essentially designed for recreation and this must of course be one of their major functions. But the recreation for which they serve is secured under conditions particularly favorable to education and growth of mind and spirit as well as of body.

Under the guidance of recent administrations National Parks have developed steadily in the direction of educational influence thru use of the unsurpassed illustrations of natural phenomena, which were the features that brought about their creation as separate establishments under the Government.

There are not in America other places where there may be found so great an opportunity for effective adult education concerning nature with the grandest products of creation themselves as teachers. there is nowhere a larger opportunity to teach clear thinking, and to prepare a multitude of minds for honest reasoning. It is like a super-university, where the professors would be only guides and not instructors. And why should we not have for this great possibility of educational work an endowment adequate to prepare the way for most effective use by all to whom the opportunity comes, and a faculty chosen from the leaders in thought and appreciation; a group of men who, standing in the vivid presence of the Creator, would speak only the simple truth ?

While the National Parks serve in an important sense as recreation areas, their primary uses extend far into that fundamental education which is true appreciation of nature. Beauty in its truest sense receives expression and exerts its influence along with recreation and education. To me the parks are not merely places to rest and exercise and learn. They are regions where one looks thru the veil to meet the realities of nature and the unfathomable powers behind it.

THE NATIONAL PARK SERVICE.

by Ranger Marguerite Lindsley.

Approved by: Superintendent Horace M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
J. E. Haynes, Acting Director, Yellowstone Park Museum.

The National Park Service. What does that mean to you ? In reality it is a great organization of red-blooded Americans who guard and protect your playgrounds. Playgrounds, that is what the national parks are; areas set aside for the "benefit and enjoyment of the people".

The National Park Service is only eleven years old. Yes, there were national parks before that, but they were administered directly by the Secretary of the Interior, and several, including Yellowstone, were policed by detachments of the regular United States Army. For thirty years out of the fifty-five of its existence the superintendent of Yellowstone National Park was the commanding officer in charge of the troops stationed at the cavalry post, Fort Yellowstone, near the north entrance of the park.

Soon after the act of Congress creating the National Park Service, Mr. Stephen T. Mather resigned his position as Assistant to the Secretary of the Interior to become its Director. Director Mather is a white haired gentleman, erect and with very blue eyes, - the kind of eyes you find in men who have spent their lives seeing skies, seas, mountains and all out of doors. His interest in the national parks is a very personal one. He gives all of his time to them. Morning, noon and night he is planning for them. In his office in Washington or traveling from one end of the United States to the other and from Alaska to Hawaii. One of his chief amusements is to be taken for an ordinary ranger. On a hot, dusty August afternoon I saw him standing in the middle of the road at Tower Fall in the Yellowstone, - directing traffic. Once in a while he stopped a car to ask the occupants if they were enjoying their trip, if they liked the park, or if the rangers were giving them good service.

Since 1915 when Director Mather first became interested in National Parks he has been instrumental in having set aside seven of the finest of the nineteen. Rocky Mountain in Colorado, Hawaii, Lassen Volcano in California, Mt. McKinley in Alaska, Grand Canyon in Arizona, Zion in Utah and Lafayette, which, by the way, is the only park east of the Mississippi at present.

Director Mather's bureau, the National Park Service, has jurisdiction over more square miles of territory than six times the size of the State of Delaware, more than 13,000 square miles, all national parks or national monuments. National monuments are smaller than national parks usually, being set aside to preserve a single object of interest or a small area of land such as a prehistoric cliff dwelling or an exceptionally unusual geological phenomenon.

All other federal lands may be and are, developed commercially. National Parks are great natural museums, to be preserved in their natural state; the flowers, trees, birds and animals to be protected and cared for. Last year the national parks were visited by more than two millions of visitors, - perhaps there will be three million in 1927. These people must be cared for, accomodations provided, their good health guarded, protected from accident, furnished entertainment and educational facilities, and at the same time the natural beauties of the parks must be protected and their objects of scientific or historic interest guarded. As Director Mather says, "It is a big job!"

And the man who is responsible in the individual park is the superintendent of that park. I use Yellowstone as an example because I know conditions there better than elsewhere and also because it is the largest and oldest of the national parks. Superintendent Horace M. Albright is another whose energy, ambition and enthusiasm for the National Park Service and for Yellowstone is genuine and unbounded. He has his organization running smoothly all of the time and that is no mean task, keeping track of the various departments and overseeing all that is done. If anything goes wrong he must be responsible. He attends conferences, exchanging ideas with the superintendents of other

national parks, having at his immediate command all of the innumerable details in his own park. If a ranger makes a mistake the report goes to the superintendent. If an accident occurs the superintendent reports it in detail to Washington. He could easily have the title, "Chief Coordinator".

Other Departments of the Federal Government cooperating with the National Park Service in Yellowstone are :

(1) The United States Weather Bureau (U. S. D. A.) maintains an important observatory station there.

(2) The Bureau of Fisheries (U. S. D. C.) has a large fish hatchery at Yellowstone Lake.

(3) The Public Health Service (U. S. T. D.) makes inspections of all sanitary conditions, testing drinking waters, installing disposal plants, controlling mosquitoes, etc.

(4) The representative of the Department of Justice is an U. C. Commissioner, Judge John W. Meldrum. Judge Meldrum has been in Yellowstone Park in this capacity for 33 years and he says that business has picked up considerably since they allowed the cars in twelve years ago !

People who are traveling have to write home and tell the folks what the Park is like and picture post cards tell the story with the least effort. Often 20,000 post cards are mailed from Yellowstone Park post office in a single day.

(5) Since a malignant disease called "hemorrhagic septicemia" threatened to destroy the whole buffalo herd in a single season, the calves are vaccinated each spring, and that is done under the supervision of the Bureau of Animal Industry (U. S. D. A.)

(6) Where there are forests, insect pests must be controlled and the Bureau of Entomology (U. S. D. A.) handles this.

All of these bureaus and departments make Mr. Albright's work more complicated and difficult, but he knows that with their aid the best results can be obtained.

And now we come to the ranger force, comprised of 87 men in whose hands rest the responsibility of the care of that great park. Two millions of acres and 87 men. Seventeen thousand elk, 900 buffaloes, hundreds of other animals, and 87 men. 35 in the winter time. More than half of the force, the temporary rangers, leave when the park season is over. That all means that the life of a national park ranger is far from the proverbial "bed of roses". During the season they ride horses or motorcycles, chasing speeders or looking for forest fires as the case may be. They round up the buffaloes and for this they must have the most alert and the fastest horses available. A buffalo is never friendly and he often turns suddenly in his tracks and charges a man on horseback. Buffaloes sometimes appear very awkward and lazy as a tourist sees them on a warm sunshiny afternoon, with a good stout fence intervening; Their ropy little tails switching at flies and their tiny black eyes hidden in the dark, curly hair of their faces. But they are probably the most to be feared of the park animals and their protection is at once a delicate and dangerous task.

Forest fires are not uncommon during the late summer when the trees and underbrush are dry and there are many electric storms. Sometimes in fighting fires the rangers have to go without proper food and water, sleeping on the ground in their smoked and charred clothing when they can't stay awake any longer; for days fighting fires that rage on the higher plateaus away from the roads and trails, and even miles from water. Equipment must be brought in with horses. Horses must have trails cleared for them in some places, unbridged rivers must be crossed, water carried and trenches dug. Then, when apparently extinguished, a large fire will smoulder for days in the deep mat of dry pine needles, bursting into flame again in a single wind.

The park is just as wild today, back away from the beaten trails and roads, as it was more than a hundred years ago when white men first visited it. It is easy to climb to the top of some mountain and look for miles in every direction, seeing nothing but more mountains, lakes, rivers, and forests. No roads, no trails, no visible signs of man's existence, just wild, untouched country. A world in balance - equilibrium. Doesn't wilderness affect you that way ? Does it ever make you realize your insignificance if you are feeling a bit too proud of yourself ? And then if you are despondent doesn't it have just the opposite effect, making you feel better ? Or haven't you ever been there ? In the wilderness, I mean. If not you have missed something that you owe yourself.

Just 35 men in the winter, but animals do not require the constant attention people do. They don't ask questions ! But hundreds of tons of hay are fed to the buffaloes, elk, antelopes, deer and mountain sheep each year, and this is done when the weather is the coldest and the snows are the deepest, and frozen hands, ears and feet are not uncommon, - the ranger is true to his trust, the park animals.

Snowshoes and skis make travel in the winter possible. Yellowstone Lake, 23 miles long, freezes over and the men ski across it, saving many miles.

Assistant Chief Ranger Joe Douglas is a man you'll never forget if you are fortunate enough to meet him. He can tell enough stories to keep you sitting up all night beside a campfire listening; true stories of his experiences. He is very active and as he goes skiing along he is always singing a little song, - no one can tell you what it is but he is always humming it, - unless he knows you are listening. One day when the thermometer registered something like minus ten, ranger Douglas started out across Yellowstone Lake to the Lake Ranger Station, fifteen miles away. He struck an air hole in the ice and broke through. He was carrying his skis and they caught on the edge and kept him from going clear through or he would have been lost. He finally managed to climb out alone but the minute the air came in contact with his clothes they froze solid with ice. His duty lay in being at Lake that day, so he skied the remaining twelve miles with his clothes frozen to him, - not exactly a pleasure trip.

A humorous experience comes to mind. At that it probably was not so funny when it happened ! Another ranger was skiing along a very narrow trail above a frozen stream, when he turned a sharp curve and found that three or four (he has never been quite sure which) wild buffaloes, some of the so-called Mountain Herd, were coming toward him on the same trail. He <u>landed</u> on the ice of the little stream, turned around and traveling ! When he went back later he found it was not <u>possible</u> for a man to make the jump on a pair of skis that he had made and light running. A buffalo is very large and very heavy and this ranger said that they give the impression of a snow plow in deep snow, - except that the snow plow is hindered by it more than a buffalo.

In the winter the rangers keep close track of all of the animals and the indications of their general health. When one is found dead it is reported immediately to the Chief Ranger, with a statement of the apparent cause of death. Such predatory animals as the wolves, coyotes and mountain lions are killed, under the supervision of the Superintendent, so that their depredations will not affect the normal increase of the others. It is not the policy of the National Park Service to <u>exterminate</u> any of the animals but merely to keep in check their numbers so that they will not do too much damage.

Rangers have many wild animals for pets. Often they are rescued by these men, - young, sickly animals, deserted by their parents, or small animals left orphans by the death of their mothers. And full grown ones are often made pets too; for instance this winter, nearly every ranger station has a pet marten or a pair of them. One particularly well known pet was Bill the elk. Bill was raised on a bottle from a spotted, big-eared calf with knock knees, until he finally adopted the buffaloes for his playmates. One spring he followed some of them when they were being brought in to Mammoth to be placed on display during the season. Bill stayed with us for a long time. He must have liked Mammoth

people and I know he liked their clothes. He made the rounds of the clothes lines every monday, eating various things. At present there is a young buffalo known as "Grunt" at Mammoth, which is daily becoming more of a problem, being quite affectionate and demonstrative already to the point of knocking you down.

And why do these rangers stay in Yellowstone ? If you ask them they can't tell you. There are lots of hardships, - I have told you of only a few of them.

They stay because their hearts are in their work. It is the thing they are best fitted to do if it is the thing at which they are the most contented. They appreciate the dependence of those little animals. They realize the responsibility of their jobs in keeping that country just as it is, they work hard and they gain satisfaction.

Last year I met one of the younger rangers while away on his vacation. He had not been away from the park for over a year, and he had not been home, St. Paul, for three. He had thirty days of annual leave due and I saw him when one week of it was gone. He was already planning on getting back, wondering how his pardner was getting along out on their station alone, envying him !

In closing I will tell you how Chief Ranger Sam Woodring spent his Thanksgiving two years ago. The day was given over to a lion hunt, and resulted in the capture of one of the largest specimens ever taken in the park. The Chief and a party of others set out early in the morning with a pack of trained dogs. Within an hour after they had found the tracks of the big cat they had him treed. They hoped to make a capture rather than a killing and cut down three trees in trying to get their ropes on him. He waited each time until the tree started to fall and then leaped thru the air, over their heads, landing twenty or thirty feet away, running. Each time they were successful in getting their ropes on him, he clipped them with his teeth like so much twine. He traveled like greased lightening but could not keep it up long enough to lose the dogs. The experience must have been a real one and they hated to resort to their guns to bring the great snarling cat from his tree. This lion is mounted in a most life-like manner in the Museum at Mammoth Hot Springs.

All visitors who see it are reminded that hidden dangers still lurk in the shadows of the Yellowstone, dangers especially for those little hoofed animals that people so love to see as they leap to safety in the bushes along the roads or as they are found grazing in some sheltered nook away from the main traveled ways.

This has been much too brief, - just a general talk on some of the things which seem to me to make Yellowstone National Park appeal so strongly to those of us who know it very well.

THE HISTORY OF YELLOWSTONE NATIONAL PARK

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

The present Yellowstone National Park was a part of the territory acquired by the United States under the terms of the Louisiana Purchase of 1803. So far as our records show, the first white man to enter this area was John Colter. The circumstances attendant upon his coming briefly were these. He was a member of the expedition headed by Lewis and Clark, and when that party reached Fort Mandan, North Dakota, in 1806, on their return from the west, Colter applied for a discharge in order to visit certain sections of the west to hunt and trap beaver, together with two hunters, Joseph Dickson of Illinois, and Forest Hancock, or Forrest Handcock, of Boone's Settlement, whom the expedition had met up with while descending the Missouri. Dickson and Handcock were returning from an unsuccessful winter and were glad to have the company of a recognized hunter and woodsman. Colter's application was granted, and the winter of 1806 he spent in what is now called the Jackson Hole country, outside the present southern boundary of the Park. Early in the spring of 1807, Colter and a man named Potts entered the southern part of the Park.

At this time there were three tribes of Indians in and around this particular area. These were the Crows, the Sheepeaters (of the Shoshones), and the Blackfeet. The Crows generally were friendly to the white men. The Sheepeaters were a degenerate tribe, stunted physically and mentally and as such were not in a position to give trouble to anyone. The Blackfeet, on the other hand, were the bitterest enemies the white men ever had among the Indian tribes. "They were the terror of the trapper and miner, and hundreds of pioneers perished at their hands. Like the Crows, they were a well-developed race, good horsemen and great rovers, but, in fight, given to subterfuge and stratagem rather than to open boldness of action." (Chittenden: The Yellowstone National Park, p.6). The fact that the Crows were friendly to the white men and the Blackfeet were not was due to the same circumstance. There had occurred a battle between these two tribes the year before, in which Colter had taken part on the side of the Crows. It should be explained that it was not entirely disinterest that led Colter to this position. He, while engaged in a scouting expedition at the instigation of Manuel Lisa, a trapper, had fallen in with the party of Crows and was merely spending the night with them when they were attacked by a number of Blackfeet and he was forced, in self defense, to fight on their side. The Crows, and as it developed, the Blackfeet, as well, believed that the Crow victory was possible because of the presence of the white man, and gratitude to him for his assistance led the Crows to be friendly to all white men from that time on. On the other hand, the Blackfeet felt that their defeat had been due solely to his presence among the ranks of their enemies, and they never neglected a chance to revenge themselves on any white man with whom they came in contact. Colter and Potts were attacked by Blackfeet Indians and Potts was instantly killed. Colter barely managed to escape with his life and fled into what is now the state of Wyoming, where he took refuge in a trading fort. The story of his escape, which is told elsewhere at length, is one of the most thrilling of all the spectacular tales of the pioneers. The year following, he attempted to re-enter this area with no weightier purpose in mind than to recover about five or six dollars worth of traps which he had dropped the previous year while running from the Indians. He did not find the traps, but he found the Blackfeet, who again caused him to leave the region in haste. The next year, (1809) he made a third attempt to explore the region now included in the Park boundaries, following which he returned to Saint Louis where he told the stories of the geysers and hot springs he had seen there on his three visits. His stories were not believed and a newspaper of that time humorously referred to the region as "Colter's Hell".

The second white man to enter the Park was the notorious Jim Bridger. Bridger spent about three years in the Park, being on friendly terms with all tribes of Indians found around that section, which might possibly be explained by the fact that he was able to find relations by marriage among most of the tribes in the west at that time. At the end of his three years here, Bridger returned to Saint Louis as Colter had done before him, where he also told the stories of the wonders of the Park. Likewise, he was not

believed. Up until this time, Bridger had been a truthful man, but when he began to gain for himself the reputation of a liar, he thought he might as well earn it, and so he began to embroider just a little. As a result he left us some of the most remarkable stories in the English language. However, despite the unusual stories which Bridger left us concerning the Park, he left us also a great deal of valuable information concerning the Park, for although a man of no education, he possessed a knack for map drawing and his maps of the Park are surprisingly accurate even when judged by our present day standards. It is a matter of conjecture just how many of the wonders of the Park Colter and Bridger actually saw. Colter's stories are so obscured in the tradition of the border that it is difficult to select the original information, but it is proven without doubt that he did actually traverse part of the Park in 1807, touched the West Thumb of Lake Yellowstone, (then called Lake Eustis), passed by the Canyon, (in all possibility missing the Falls,) and observed several"boiling springs" and at least one fossil deposit. A map made by Clark and published in 1814 shows superimposed a route marked as "Colter's route in 1807". The map is highly inaccurate but establishes beyond doubt the fact that he was within the boundaries as they now exist. Bridger's stories, though fantastic to the highest degree, in detail always contain a germ of truth. Colter's failure to see the Great Fall of the Yellowstone was due likely to the fact that the walls of the Canyon cut off the view from any distance, and also by the turns in the River itself. "It is a curious circumstance that Lewis had heard of the Fall from some Indian source, but later concluded that the information so obtained was incorrect. He wrote in the original Journals, as they appear in manuscript, as follows 'there is also a considerable fall on this river (Yellowstone) within the mountains, but at what distance we never could learn.' This particular entry is marked by Lewis in red ink, followed by the word 'No'." Thwaites, V,p.320.

After Bridger, came some of the gold-seekers of 1849, who entered the Park, but finding no gold there, went on to California. In 1859 a small military expedition under the command of Captain W. F. Raynolds of the United States Army entered the northern section of the Park, but were not able to penetrate it very far because of the great depth of the snow. In fact, the snow is one reason why this area was not explored sooner. There are, in reality, only about three and one half months of the entire year during which it is possible to move freely about in the Park. During the other eight and a half months there is an average depth of between four to fourteen feet of snow, and progress is impossible except by snowshoe or ski. Other reasons were danger from the Indians, lack of interest in explorations except as it had to do with the discovery of gold, decline of the fur trade and the subsequent with-drawal of the trappers, and the Civil War, which gave the Government plenty to do in the east and discouraged any official explorations or geological surveys.

The second most important expedition in the history of the Park was the Cook-Folsom-Peterson Expedition of 1869. These three men were residents of the Territory, as it was then called, of Montana. They entered the Park and saw all the principal points of interest save the Upper Geyser Basin alone. They saw geysers and hot pools at other places in the Park, however, and returned to Montana, where they told stories of the wonders which they had seen. Even as late as 1869 their stories were not believed, or at least, were thought exaggerated.

The stories which they told were sufficient to warrant the formation of the official exploring party of 1870, known to us today as the Washburn-Doane Expedition. This was official only in so far as it was given a military escort, for it was composed of prominent Montana citizens who were influential enough to procure an escort consisting of Lieutenant Doane and four enlisted men. For the greater part, the small party was made up of men who were persons of importance in the Territory. Mr. Washburn, whose name was given to the expedition, was at this time Surveyor - General of the Territory, and other members of the expedition afterward became very prominent in western affairs. The official report made by Lieutenant Doane of this expedition was called by General Hiram Chittenden "the most masterly military report ever made by an American Army officer". The expedition entered the

Park in the northeast corner near what we now call Tower Falls (approximately the point at which Colter had left the Park sixty years earlier) and followed the route which most of the present-day tourist traffic in the Park follows. From Tower Falls they went to the Canyon, from the Canyon to the Lake, and from the Lake to the West Thumb, from which point they went to the Upper Geyser Basin. Arriving there, the first sight which fell on their eyes was that of Old Faithful Geyser in action. This geyser, as well as most of the larger geysers and hot pools in the Upper Basin, received their names from members of this party, who spent a day and a half at this point and from here went to the junction of the Firehole and Gibbon Rivers, which is now known as Madison Junction. It was while encamped here, on the night of September 19, 1870, that the"National Park" idea was born. The discussion started over the question of what should be done with this great region, now that its authenticity was unquestioned. The first thought, of course, was the advancement of self-interest and enthusiastic plans were presented for the fencing in of some of the principal points of interest and the charging of admission. Fortunately, far-sightedness and unselfishness won the day and it was resolved that the efforts of the party would be to interest the Government in the great tract that it might be held as the property of the People for all time to come. This suggestion was acted upon, most of the necessary work being done by Nathaniel P. Langford, since Mr. Washburn had died early in 1871 and on the first of March, 1872, President Ulysses S. Grant signed the Act, dedicating this as a national park "for the benefit and enjoyment of the people".

But dedication, unfortunately, was not preservation, and the subsequent history of the Park for years is one of constant effort on the side of the public-spirited to preserve this wonderland from the depredations of individuals who saw in it a chance for personal aggrandizement. One of the Park's most zealous protectors was Mr. Nathaniel P. Langford, who had been a member of the Washburn-Doane Expedition, and who had personally done so much toward the accomplishment of the National Park project. He was appointed as the first superintendent, without salary, and served the first five years of the new Park's existence. He further spent much of his private fortune in improving the Park. He was succeeded in this capacity in 1877 by Colonel P. W. Norris. Colonel Norris is responsible for many interesting discoveries and explorations during his regime, and fathered the fine system of trails now in use. Unfortunately, his successors were not always the equal of these first two superintendents and it was found necessary to put the Park under military control in 1886. From 1886 until 1916 the Park was administered by the Army.

In 1916 the present administration, the National Park Service, was founded and placed under the direction of the Department of the Interior. The National Park Service, with Mr. Stephen T. Mather as Director, has charge of all National Parks and most of the National Monuments. This service maintains the Ranger Stations and the Ranger force and endeavors that it shall be at all times "a park or pleasuring ground for the benefit and enjoyment of the people" as so aptly stated in the Act of Dedication.

THE DISCOVERY OF THE YELLOWSTONE

By Ranger Robert H. Dolliver

Most of you have been in Yellowstone Park long enough to realize that its great wonders are kept in their natural state as far as possible. No doubt you have further noticed that a sincere effort is being made to make your stay with us not only enjoyable but beneficial. The idea of setting aside great areas of this sort under the supervision of our national government where the people of this country may come and enjoy the natural wonder of America is what we call the "National Park Idea". Those who are connected with the Yellowstone Park are especially proud of the fact that this National Park Idea originated here. Yellowstone was the first park created, and since it was set aside in 1872 there have been 19 other national parks created and based on this same idea. Because I believe most Americans are interested in our National Parks and the history of their creation, I am going to talk on the subject, "The Discovery of the Yellowstone".

The Yellowstone Park region is little different from any other portion of the main chain of the Rocky Mountains in its early history. The same waves of discovery swept over it that swept over the Colorado or Montana Rockies. We might say that the Yellowstone is a gem of great wonder and beauty set in the midst of the last frontier of the American people. For the valleys and forests of this chain of the Rockies did constitute the last frontier of the American. It skipped from the Mississippi and Missouri River valleys over to our western coast, and then came back here. It was here that the last land was homesteaded, and it was in and about the mountains of Wyoming and Montana that the Indians made their last stand against the advance of the white man.

I want to mention briefly three Indian tribes that lived around the Yellowstone. I say around the Yellowstone, because very few of these Indians ever lived in the Yellowstone Park region or for that matter ever wandered in here. There was an old superstition among these northwest tribes that here was the dwelling place of the "evil spirit", and that if they came in they would anger that evil spirit. If you have been out over these formations since you have been here you can readily understand how this superstition arose. Their name for it was "Burning Mountains", but beyond that their information is scant.

The first of these Indian tribes who lived around the Yellowstone was the Crow Nation. The Crows were said to inhabit the region between the Yellowstone and the Missouri rivers in what is now eastern central Montana, but as a metter of fact, they roved the Great Plains from Texas on the south to Canada on the north, and from the Missouri River to the Rockies east and west. They were great thieves. They would sneak into the camp of some band of white settlers crossing the plains, take their finest horses or whatever property was lying about loose, and then leave camp before daybreak. They were such fine horsemen that it was usually futile for the whites to give chase. Therefore the history of our relations with the Crows consisted of a series of short wars, after each one of which the Crows again professed their friendship for the whites and again promised not to steal our property. After a few years, the Crows would forget these promises and the whole process would have to be repeated. It was not so with the Blackfeet Indians, the second great tribe who lived around the Yellowstone - to the north and the northwest. From the time Capt. Lewis of the Lewis and Clark Expedition killed one of these Blackfeet in 1804 until the last Indian troubles were over less than fifty years ago we were almost constantly in trouble with the Blackfeet. They did not hesitate to torture or kill any of the early discoverers or explorers of the western Montana region whom they happened to lay their hands upon. Furthermore they were enemies of the Crows, so that whenever the Blackfeet and Crows met, a battle ensued in which the braver Blackfeet were usually victorious. The third great tribe who lived around the Yellowstone was the Shoshone tribe. They were a great tribe living south of the Park region. The sub-tribes of the Shoshones were generally of the type who lived by peaceable means, some of them tillers of the soil. It was one small and obscure sub-tribe of the Shoshones who were the only Indians to live in the present bounds of the Park as far as we know, the Sheepeaters. This tribe was also known as "fish-eaters" or "root-diggers", derisive terms applied to them by the Crows and the Blackfeet because of their habits of eating. They dug the redish-like root of a certain sticky-leafed thistle

which grows abundantly throughout the northern Rockies, dried them, and then ground them up for their flour from which they made a pastry known as "sour-dough". Furthermore the Sheepeaters indulged in fish, a thing which Crow or Blackfoot would not do unless hard-pressed for food.

So much for the Indians who lived in and around the Yellowstone. I want to mention at least, the Lewis and Clark Expedition of 1803-6, because of the importance of their discoveries. Although they did not come into the Park region itself, they passed within a hundred miles of the Park region both going out to the Pacific in 1804 and returning in 1806. If you will go back with me to a certain June day in 1806, you will find yourselves with Clark and his followers who had separated from Lewis and were coming from the Madison River valley over the famous Bozeman Pass toward the present site of the city of Livingston, Montana, on the banks of the Yellowstone less than sixty miles north of the northern boundary. Bozeman Pass later became the trail for the first settlers of western Montana, still later a wagon road, and now it is not only the route for one of the main automobile highways across the state, but is also the route of the transcontinental line of the Northern Pacific Railroad. As Clark approached the banks of the Yellowstone near what is now the depot platform in Livingston, I can imagine he looked up the river with the longing of a true explorer and wanted to be the first white explorer to set foot in the Upper Yellowstone. But as he looked he could see the snow-capped peaks and the snow-filled passes of the Absaroka and Snowy ranges which shut out the Yellowstone on the north. He knew the difficulty of traveling in snow-filled passes in the late spring, and furthermore when he asked his Indian guides about the region they truthfully replied that they knew nothing. So Clark went down the Yellowstone instead of up the Yellowstone. That is a very significant fact, for had Clark explored this region and had these wonders been made known to the American people seventy years before they were, the fate of Yellowstone Park might have been the same as that of other places of great natural wonder in this country. That is, private exploitation would have gained such a firm foothold that it would have been almost impossible to establish a national park here. As it was, this area was practically unsettled and unclaimed when it was created a national park.

In the party of Clark on that June day in 1806 was a man named John Colter who was destined to be the first white man to ever set foot within the present bounds of the Yellowstone so far as we know and therefore its real discoverer. When the party arrived at Mandan, now in North Dakota, Colter met two fur-trappers who happened to be coming up the Missouri River just at that time. He asked permission of the commanders to leave the expedition and go back up the Missouri River with them, and since they were nearly home his request was granted. Here was a man who was almost within sight, we might say, of the comforts of home and civilization, and yet he was willing to turn his back on all that and to go back into the Rocky Mountain wilderness, there to endure all over again those hardships and dangers common to wilderness travel which he had just endured for three long years. There must have been something more than the desire to trap furs in the hearts of men like John Colter; there must have been something of the same lure which brings people back into this wilderness time and again even today. At any rate, Colter went back, and in the next year, 1807, we find him in the employ of a certain Spanish fur-trader of the west, Manuel Lisa. Lisa, with the aid of Colter established a fort at the mouth of the Big Horn River where it flows into the Yellowstone River northeast of the Park. The next step was to make friends of the neighboring Indian tribes and Colter was commissioned for this task. Late in the summer of 1807 he fell in with a certain band of Crow Indians, who went south around the end of the Absaroka range east of the Park region, to a famous spot 25 miles south of the Park, The Jackson's Hole - from thence across the rugged Teton range through Teton Pass to Pierre's Hole on the west side of the Tetons. Here these Crows met a band of Blackfeet and the usual battle followed. By the force of the circumstances, Colter fought with the Crows, thus becoming another link in the chain of events causing the enmity of the Blackfeet toward the whites, for the Blackfeet saw this white man fighting against them and they never forgot it.

Contrary to the usual result, the Crows were victors in this battle, so that after the battle Colter was enabled to strike out for himself to see if he

could discover some new fur-trapping lines. He came north-ward up the Snake River into the present bounds of the Park, and from thence up the headwaters of the Snake to Shoshone Lake, situated only a few miles southeast of us here. He must have been surprised to find that large body of water at the source of the Snake, but when he crossed the continental divide eastward and discovered the beautiful Yellowstone Lake, his surprise must have been much greater, for he did not suspect that so large a body of water would be found so high up on this mountainous plateau. As a matter of fact the Yellowstone Lake is one of the largest bodies of water for its altitude in the world. But John Colter was to see still greater wonders, for he went down the Yellowstone River northward and discovered the Grand Canyon of the Yellowstone. There he saw that beautiful splatch of color which has been eroded out of the side of Mount Washburn by the washing of the waters of the river through an old hot springs basin, the minerals of which have become oxidized in all the colors ranging from the lightest yellows, through the oranges and the reds, to deep purple - a sight which he must have never forgotten. He saw, too, those majestic waterfalls of the Yellowstone - the Upper Fall over 100 feet high, and the Lower Fall over 300 feet high - caused by ridges of rhyolite or lava rocks, which did not decompose as they did just below the ridges. Colter went on down the river and then up what is now known as the Lamar River and out the northeastern corner of the Park - the first white discoverer of this region as far as we know.

There were many other fur-trappers who came into this region. A few of them left traces behind. For example, in a tree . near the brink of the Grand Canyon we still can discern the carved initials "J. O. R.", and under it the date "Aug. 29, 1819", put there no doubt by one of these original discoverers not only of the Yellowstone, but of the whole Rocky Mountain region. I am speaking of the fur-trapper, for he went up to the farthest source of the farthest stream in his search for furs, and thus knew the Rockies thoroughly.

About the year 1830, the fur-trapping business became consolidated so that the fur-trader supplanted the fur-trapper in a sense. It was found profitable to bring ship-loads of supplies and trinkets up the Missouri River as far as the steamers would go, and then re-load the goods into smaller boats and come on up to the headwaters of the Missouri; or, to bring great pack-trains up the Platte River Valley, thence up the north fork of the Platte, thence over to the Wind River valley and finally up into this region. The trader would exchange his supplies to the trapper for his furs, and his trinkets to the Indian for his fur. This trading would take place once a year, usually in June, and in this northern Rocky Mountain region was held generally either in Jackson's Hole or in Pierre's Hole, just south of the Park. These meetings were called "fur-rendezvous". They were no doubt great occasions in the lives of the fur trappers and traders. They would come in from all sides, up the Snake from the soutwest, the Wind River from the southeast, and from the headwaters of the Missouri to the north, and hold not only a week's trading but a week's celebration, in which the Indians certainly took no small part. I can imagine that they "swapped" their yarns and boasted of their adventures, and then after it was over went back into the solitude of another year's trapping, no doubt looking forward with a great deal of anticipation to the next year's rendezvous.

It was the business of a famous mountaineer and fur-trader, James Bridger, to organize these fur rendezvous for the Rocky Mountain Fur Company. He crossed and re-crossed the Yellowstone Park region going to and from these fur-rendezvous and on other business connected with fur-trading. At any rate he knew more about the wonders of the Yellowstone than any other man between the years 1830 and 1870. Naturally, and I might say unfortunately for the name of James Bridger, few people would believe what he had to say about the wonders he had seen, so that there grew up about the name of James Bridger, the idea that his stories were chiefly the result of his imagination - in other words plain lies. It is no doubt true that Bridger was so thoroughly disgusted with the way in which people took his stories that, especially in his later life, he actually and purposely did add his imagination to the picture of what he had seen. Here is one of the famous Jim Bridger "stories". He said that out of the top of a certain mountain in this region there arose a spring of clear, cold, and delicious water. He would climb this mountain for no other purpose than to drink some of this water. The remarkable fact was the stream from the spring flowed so fast and furiously down the side of

the mountain, that, by the time it reached the bottom, it was boiling hot due to the friction of the water pouring over the rocks. You laugh at that, but possibly Bridger was not so far from what he judged to be the truth as you imagine. He had no doubt waded in some of these streams and had felt the warm rocks caused by hot springs which occassionally rise in the bottom, and his only explanation was that friction of water pouring over rocks caused heat. Bridger described the great petrified trees standing on a certain slope here. It is true that we have several upright fossil forests here - a rather unusual phenomenon since most fossil forests are prostrate. For example, on Specimen Ridge there are at least 12 fossil forests, and possibly as many as 15, each one of which grew on top of another after each was covered up by an eruption of mud and rocks from the volcanoes that were active in this region about a million years ago. Afterward water containing silica in solution seeped down into these trees, the wood cells broke down and a compact crystallization of silica took their place. These trees were large Redwoods and members of other species which were later driven out by the glaciers and did not afterwards come back into this part of the Rockies. But Bridger went farther than to describe these trees - he added that in this remarkable region the shrubs, grass, and flowers were standing about petrified. Furthermore, there were fine elk, and deer, and buffaloes standing about petrified, and up in the air in still flight were birds - petrified. Occassionally he seems to have added that the force of gravity was petrified so that waterfalls stood still in their course, and when he rode his horse up to the brink of a certain canyon in this region, instead of going down on one side and up on the other, he rode straight across on the air.

So much for James Bridger. He certainly adequately represents the fur-trader, another explorer and discoverer not only of the Yellowstone but of the whole Rocky Mountain region. About the year 1850, most of these streams were trapped out so that the center of fur-trading moved northward into Canada. In the decade preceding our Civil War, very little attention was paid to the northern Rockies. Capt. Raynolds was sent out to explore the upper Yellowstone, but he failed to penetrate the Absaroka range to the east. The Mormon migration of 1845-6, the California Gold Rush of 1849-50, and the Oregon migrations held the attention of the scouts and guides of this region.

At the beginning of the Civil War, however, another wave of discovery swept over the Yellowstone - the gold-seeker. Gold was discovered in the Montana Rockies in 1859-60, and by 1861 the frantic search was in full sway. Again this wave was typical of all the Rockies, for the most of these western states have had their gold rush or their silver rush at some time in their history. If we examine the areas back in the dry gullies beyond the farthest source of the farthest stream, we will find the prospect-holes of the gold seeker here even today. They are much more common, however, in the region to the north of us, for the Montana gold-rush centered about the Alder Gulch and Virginia City. I want to mention one gold-seeking party which crossed the Yellowstone. It was the party of Walter De Lacey, a citizen of Montana Territory and a surveyor by trade. He came from the south up the headwaters of the Snake River to Shoshone Lake. From Shoshone he came this way up a little stream now named after him, De Lacy Creek. He then crossed the Continental Divide on the ridge just east of us here and then followed down Nez Perce Creek and camped at the Lower Geyser Basin. The only mention anyone in that party made of the wonders they had seen was made in a short paragraph in the diary of Mr. De Lacy himself, even though they must have seen at least the Great Fountain Geyser, if not others, in eruption, judging from the description. It was certainly typical of the gold-seeker. He didn't have time to observe the wonders of nature about him, but rushed on and on in his search for gold - gold - all the time.

We do have to give credit to the gold-seeker for bringing to the attention of the citizens of Montana territory the fact that there were great wonders to be seen here. So after the Civil War was over and matters had begun to settle down a little there began to be talk of organizing an expedition to discover the truth about the upper Yellowstone. It took shape in the Folsom-Cook party of 1869. Unfortunately, the military aid promised this party was withdrawn at the last moment on account of a new outbreak of the Blackfeet Indians against the whites. Most of those who had signed up with the party withdrew, so that only three men, Folsom, Cook and a man named Peterson actually went. They were too poorly equipped and spent too little time here to be called the real discoverers of the Park, although they certainly deserve a lot of credit for their interest and for coming in face of possible death at the hands of hostile Indians. They missed seeing this Upper Basin where most of the large geysers spout.

THE DISCOVERY OF THE YELLOWSTONE -- Doliver.

We generally give the credit for thorough discovery to the Washburn-Langford-Doane Party of 1870. It was composed of nineteen men, many of them at that time and later prominent citizens of Montana Territory. The commander chosen was Henry D. Washburn, who had been a major-general in the Civil War. Then there were N. P. Langford, solicitor-general of Montana Territory and afterwards superintendent of the Park for many years; Lt. Doane, who commanded the military escort of five men; Cornelius Hedges, then a banker, and appointed at one time as governor of Montana Territory; Truman C. Everts who became separated from the rest of the party south of Yellowstone Lake and wandered for 37 days with little food or shelter; Samuel T. Hauser; and Jake Smith, who was picked up at the last minute from Virginia City, the starting point of the expedition, and who proved to be a thorn in the side of the expedition. Every time Jake Smith was put on guard duty he fell asleep so that during the later part of the trip he was no longer trusted and so was relieved by some one else in his turn - much to his liking. The party came up the Yellowstone River and climbed a mountain which they named after their commander, Mount Washburn. The panorama spread out before them surprised them. Everywhere columns of steam were rising from the hot springs and fumeroles of the eastern portion of the park, then more active than now, and far to the southward they glimpsed a large body of water which they correctly guessed was Yellowstone Lake. They then proceeded to the brink of the Grand Canyon. The spectacle spread out before them so entranced them they hesitated to leave, but since they had only thirty days provisions with them, they hurried on up the Yellowstone River southward and explored the region of Yellowstone Lake. Instead of going around the north shore, which would have been much easier, they went around the south shore of Yellowstone Lake, thus delaying their journey several days. Finally they emerged at the West Thumb of Yellowstone Lake and saw those hot springs there. By that time they imagined they had seen about all the hot springs phenomena that they were going to see. So that when they crossed the Continental Divide and came down the Firehole River, and emerged out on to the Upper Geyser Basin not far from where we are now, they were utterly surprised to see a column of water suddenly ejected into the air 150 feet. According to their records, it was the Old Faithful Geyser which just happened to play at the time they emerged from these woods. It must have seemed a wonderful sight to see a column of water thrown into the air and fall over like a thousand sky-rockets at once. They were so interested that they spent some time here, and observed many of the other geysers, naming at least six of the largest. In fact, about half of the names we use for the physical features of the park today were given by members of this party. They named Old Faithful because of its apparent regularity and dependability. They also named the Castle, Grotto, Riverside, Beehive and Giantess geysers.

Finally the expedition went on down the Firehole River to the place where it joins the Gibbon to make the Madison, and camped there for what proved to be their last night within the present bounds of the Park. They camped at the base of the National Park Mountain, named after the events I am about to describe. After the evening meal the men were seated about the camp-fire and they fell to discussing what should be done with the wonders they had seen. Since this was a privately financed expedition it was natural that the first suggestion made should be that each man interested stake out a claim about the edge of the geyser basins and around the brink of the Grand Canyon, and then in later years sell to the public the right to see these wonders and pocket the money. Fortunately another suggestion was made that evening. It fell to the honor of Cornelius Hedges to get up and suggest that this region be set aside as a national resort under the supervision of our national government so that everyone might benefit equally thereby. Although Mr. Hedges deserves the credit for suggesting the right thing in the right place first, many other men, some of them before Mr. Hedges and certainly many afterwards had this same idea and worked hard for it. The result of their demands finally took shape, after our national government had sent out the Hayden party of 1871 to take scientific data, etc., in the act of March 1, 1872, which created the Yellowstone National Park. It set aside an area of approximately 1,200,000 acres - nearly as large as the state of Connecticut, and the largest national park ever created, as well as one of the largest game preserves not only in this country but in the whole world.

One of the phrases used in the act was "For the benefit and enjoyment of the people". These words are the ones you will find engraved on the northern entrance arch to Yellowstone Park at Gardiner, Montana, and these are the words that come closer to describing this national park idea that I have been talking about than any others. As you go around the loop, I hope you will catch the spirit of this national park idea so that those who come after you will be able to enjoy these wonders as you have. And when you get home I hope that you will do all you can to oppose measures which aim to destroy the great natural wonders of this country for seeming commercial advantages. I am speaking definitely of certain measures that come up from time to time not only in our national Congress, but in various state legislatures, measures which have dared demand that parts of our national parks and other beauty spots be laid waste. You could do nothing better to promote the National Park Idea and the spirit back of it than to write to your Congressman and legislators and ask them to vote against such measures.

* * * * * * * * * * * * * * * *

(Approximately 4500 words. This is the evening lecture given at Old Faithful during the 1926 season by me. You realize that I have put in more material than could ever be given at one lecture, unless the time were extended to about 45 minutes. The part concerning the Indians, the gold-seeker, the Folsom-Cook party, or the conclusion, might be omitted. 30 minutes is long enough to discuss the subject in a sketchy manner.)

FRAGMENTARY EVIDENCES OF THE PRESENCE OF EARLY VISITORS TO THE PARK REGION.

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

In 1880 Colonel P. W. Norris, then Superintendent of the park, discovered what is believed to be, after Colter's, the oldest proof or record of the presence of the white men in that region. In a ravine about a quarter of a mile above the Upper Fall Colonel Norris found an ancient tree upon the bark of which, partly overgrown but yet decipherable, was the inscription "J. O. R." "Aug. 29, 1819". Careful investigation of the names and exploits of all the early trappers, hunters and scouts has failed to even remotely indicate the identity of J. O. R. After a brief recital of Colter's exploits Colonel Norris states in his annual report for the year 1880 "The next earliest evidence of white men in the park, of which I have any knowledge, was discovered by myself at our camp in the little glen where our bridle path from the lake makes its last approach to the rapids, one fourth of a mile above the Upper Fall. About breast high on the west side of a smooth .. pine tree, about 20 inches in diameter were found, legibly carved through the bark, and not materially obliterated by over-growth or decay, in Roman capitals and Arabic numerals, the following record:

J. O. R.
Aug. 28, 1819

The camp was soon in excitement, the members of our party developing a marked diversity of opinion as to the real age of the record, the most experienced favoring the theory that it was really made at the date as represented. Upon the other side of this tree were several small wooden pins, such as were formerly often used in fastening wolverine and other skins while drying (of the actual age of which there was no clew further than that they were very old), but there were certain hatchet hacks near the record, which all agreed were of the same age, and that by cutting them out and counting the layers or annual growths the question should be decided. This was done, and although the layers were unusually thin, they were mainly distinct, and, in the minds of all present, decisive; and as this was upon the 29th day of July, it was only one month short of sixty-two years since some unknown white man had there stood and recorded his visit to the roaring rapids of the "Mystic River" before the birth of any of the band of stalwart but bronzed and grizzled mountaineers who were then grouped around it. This is all which was then or subsequently learned, or perhaps ever will be, of the maker of the record, unless a search which is now in progress results in proving these initials to be those of some early rover of these regions. Prominent among these was a famous Hudson Bay trapper named Ross, whose grave I have often seen (the last time in going to the Bighole battlefield for the bones of Lieutenant Bradley, in 1879) where he was long since killed by the Blackfeet Indians in Ross's Hole - as parks (parts?) were then called - at the head of the Ross Fork of Bitter Root branch of the Hell Gate in Montana, and which was named after him; as was also, perhaps, the branch of Snake River in Idaho, where the Shoshone Indian Agency is situated. The "R" in the record suggests, rather than proves, identity, which, if established would be important, as confirming the reality of the legendary visits of the Hudson Bay trappers to the Park at that early day. Thorough search of the grove in which this tree is situated only proved that it was a long abandoned camping ground. Our intelligent, observant mountaineer comrade, Phelps, upon this, as upon previous and subsequent occasions, favored the oldest date claimed by anyone, of the traces of men, and, as usual, proved to be correct." (Fifth Annual Report of the Superintendent of the Yellowstone National Park by P. W. Norris, Superintendent. 1881.) It should be noted in this connection that an error made by General Chittenden in his admirable book "The Yellowstone National Park" has been repeated variously. General Chittenden erroneously transcribed the date of the record as "Aug. 19, 1819" on page thirty-three of that book. Mr. John H. Raftery, evidently used General Chittenden's book for a source and repeated the error on page five in preparing the material embodied in Senate Document No. 752, 60th Congress, 2d Session, entitled "Historical and Descriptive Sketch of the Yellowstone National Park".

FRAGMENTARY EVIDENCES OF THE PRESENCE OF
EARLY VISITORS TO THE PARK REGION. Hall.

On page 982 et seq of "Report on the Yellowstone National Park" signed by P. W. Norris, Superintendent of the Yellowstone National Park and Hon. Carl Schurz, Secretary of the Interior, Washington, D. C. there is the following:

Mount Washburn is alike the great landmark, observatory, and unavoidable obstacle upon the route from the forks of the Yellowstone to its falls and lake; and a route less elevated, bleak, and snowy than that now used over the western spur is exceedingly desirable. Fully aware of this, I have for years sought for record of tourist or explorer, or legend of mountaineer, claiming to have ever passed between Mount Washburn and the Grand Canyon, but utterly failed, and my injury at Tower Falls checked my personal efforts of last year. Nor did I find an opportunity this season until September 26, when with Adam Miller and R. B. Rowland, the two most experienced mountaineers of those regions, and five good horses, I started to explore it. From the falls of Tower Creek, I explored its canyon and the canyon and valley of Antelope Creek above it, the timbered plateau between them, and also that between the latter and the Grand Canyon. I found the latter very elevated - mainly an excellant route, with magnificent scenery - and past the ruins of an ancient, once loopholed, earth-roofed block house some 16 x 20 feet in diameter and of unknown origin, to a dense forest at the foot of a bald rocky spur of Mount Washburn." This report is dated December 10th, 1878.

"An earth-roofed, loop-holed cabin, 16 x 20 feet in diameter, discovered by Ffederick Bettler, and visited and described by me in 1878, was almost entirely destroyed by the great fire of 1879. It was situated between Antelope Creek and the Grand Canyon, below Mount Washburn. Nothing is certainly known of its ... age, or of the character of its builders, but the advanced decay of the timber of which it is constructed, its fallen roof and generally dilapidated condition, indicate that it was the work of Hudson Bay or other trappers forty or fifty years ago. In corroboration of this theory is the absence of port-holes opening alike each way as usual and proper in the new general use of fire-arms by Indians. This arrangement would have allowed a warrior armed with bow and arrows, by stealthy maneuvering in darkness through the timber to have used his weapons in silence and within point blank range in front with terrible effect, but which in trapper days was prevented by using loop-holes, each open but one way, but alternating in direction, thus preventing a bowman from reaching a dangerous position before exposed to loop-hole cross-fire." Norris: Annual Report of the Superintendent of the Yellowstone National Park for the year 1880)

The "Report on the Yellowstone National Park" signed by P. W. Norris and dated October 20, 1877, states on page 6:

"Anxious to explore the nearly unknown northern portions of the Park and its approaches, I crossed to Emigrant and over the basaltic terraces bordering a chain of lakes to Fitzgerald's lonely ranch, at the foot of Dome Mountain.

"Near these lakes, the basaltic terraces back of Bettler's and in Trail Creek Pass are long, often parallel, lines of small rude stone-heaps, and near the latter many mining shafts and drifts of some prehistoric race for a rare, wavy, ornamental rock, the first evidence of ancient mining discovered in those regions. From their adjacent burial-cairns, discovered by me in 1870 (?), specimens of this rock, arrow heads, and other implements and tools of obsidian or volcanic glass, were found and sent to the Smithsonian Institution, hoping for future interesting explorations."

On page nine of this same report, Colonel Norris again refers to his"visit of 1870" as follows:

"When returning from a fruitless effort to reach the geysers in the spring of 1870, I at Bettler's met Adam Miller, who after subsidence of the floods which had disabled my comrades and forced our return, ascended the main river and East Fork, and discovered the Soda Butte and Clark's Fork Mines.

"This was months in advance of Washburn, Doan and comrades, the first in any sense official explorers of the park, and nearly two years before it was legally declared such . . . .".

FRAGMENTARY EVIDENCES OF THE PRESENCE OF
EARLY VISITORS TO THE PARK REGION. Hall.

I have found no refernce in any of the well-known commentators to this early attempt of Colonel Norris to penetrate the Yellowstone fastnesses, nor any reference to Adam Miller.

A summary of early evidences as discovered by Colonel Norris is attached to and made a part of his report dated December 10, 1878, and is as follows:

"Border legends, although often gross exaggerations, are seldom wholly false, and scores of them indicate that white mountaineers did long ago occassionally visit portions of the park for trapping or concealment, and perhaps both. This is, in fact, proven by ancient stumps of trees cut for breastworks and for foot logs across the Crevice, Hellroaring and other mountain torrents, which no experienced mountaineer would fail to recognize as those of white men, from being rounded from below in a way never practiced by any known Indians. Also a corral near Amethyst Mountain, and the ruins of an ancient blockhouse with earth roof and port holes, clearly the work of unknown white men, near the Grand Canyon below Mount Washburn, and a cache of martin steel traps of a peculiar form only used by the Hudson Bay trappers some fifty years ago, which were recently found along our road near the Indian arrowhead quarry at Beaver Lake."

The Washburn-Langford expedition of 1870 found near Mud Geyser, on the east bank of the Yellowstone River, an old dismantled pit or trench which might have been used as a place of concealment for hunters of water-fowl.

Mr. N. P. Langford, in the description of the ascent of the Grand Teton (which is set forth at length in another section of this manual) states "We found on one of the buttresses, a little lower than the extreme top of the mountain, evidence that at some former period it had been visited by human beings. There was a circular inclosure, about seven feet in diameter, formed by vertical slabs of rough granite, and about three feet in height, the interior of which was half filled with the detritus that long exposure to the elements had worn from these walls. It could not have been constructed less than half a century ago".

Perhaps some future student of history will unravel these faint clues to the earliest visitors.

RAYNOLDS' EXPEDITION, 1859-60.

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

On the 13th of April, 1859, Captain W. F. Raynolds, of the corps of Topographical Engineers, U. S. A., eas ordered to explore "the region of country through which flow the principal tributaries of the Yellowstone River, and the mountains in which they, and the Gallatin and Madison Forks of the Missouri, have their source". A large expedition was organized under the direction of Captain Raynolds. James Bridger, famous as a scout throughout the West and known to every Yellowstone visitor for his most delightful stories of the wonders of the Park, was guide for the party. Dr. F. V. Hayden, afterwards the director of the U. S. Geological Surveys made of the Park, was attached to this expedition as geologist.

The party started across the country from Fort Pierre, on the Missouri River, in the spring of 1859, passed along the north side of the Black Hills to the valley of the Yellowstone and then up that valley to the mouth of the Big Horn River, up the valley of the Big Horn to the Big Horn Mountains, and southward to Deer Creek, a tributary of the North Platte about one hundred miles above Fort Laramie, where they spent the winter.

In the spring the party passed up the North Platte, by way of the Red Buttes, to the valley of Wind River, ascended that stream to its source, and crossed the Wind River Mountains over Union Pass (so named by Captain Raynolds) into the valley of the Snake River. They crossed that stream near Jackson's Hole, passed up the valley northward across the sources of the little streams running into Henry's Fork on the east side, and entered the valley of the Madison throw Low or Raynold's Pass.

It is only the territory covered during the summer of 1860 which interests us particularly. After leaving their winter camp at Deer Creek, Wyoming, the party proceeded to the junction of the Wind River and the Popo Agie where these streams unite under the name of Big Horn River. Here a portion of the party under the leadership of Captain Raynolds kept up the Wind River valley and with much difficulty affected a crossing by way of Union Pass to the western slope of the mountains. It was the intention of the expedition to cross to the headwaters of the Yellowstone, follow downstream to the Great Bend and then cross over to the Three Forks of the Missouri, where they were to have united with the rest of the party, which under command of Lieutenant Maynardier, was to have skirted the east and north flanks of the Absaroka Range and to arrive at Three Forks, if possible, not later than July 1st, 1860.

To understand the failure of this expedition to follow out their original plan of procedure, it is necessary to know that Captain Raynolds had received other orders as well as the one to explore the Yellowstone basin. A total eclipse of the sun was to occur on July 18th of that year, and its line of greatest occultation lay north of the British boundary. It was desired that Captain Raynolds should be present in that locality at the time of the eclipse. He was able to carry out his original plan of exploration until nearly opposite Two-Ocean Pass, where he spent two days trying to force his way through, but it was still early in the season (June) and the snow lay too deep. It was obvious that if they were to reach Canada in time for the eclipse that no more time could be spent in this part of their exploration and Captain Raynolds reluctantly abandoned the project.

The expedition had therefore completely encircled the region of the Upper

Yellowstone. At one time Captain Raynolds had stood where his eye could range over all that country which has since become so famous. This expedition is interesting to us, not for what is accomplished, but because it gives an admirable resume, in the form of a report and a map, of the geographical knowledge of the Yellowstone country down to the date of actual exploration. The information gathered was in the main correct; one notable mistake was in judging the Tetons to be of eruptive rocks. This was corrected in the U. S. Geological Survey Report of 1872 which states on page 20 "Professor Bradley has shown that they are formed mostly of gneissic strata, penetrated here and there by dikes". The Tetons, even at this date, were regarded as insurmountable. Captain Raynolds says "These peaks are sharply pointed, piercing the clouds like needles and it is said that the trappers have never been able to get near them . . . . . The highest Teton was measured with the sextant and made to be about 10,000 feet". Twelve years later, Dr. Hayden was to see nine members of his own party attempt to scale the Grand Teton, of which two only, Nathaniel P. Langford and James Stevenson, were to be successful.

* * * * * * * * * * * * * * * * * *

Bibliography: Chittenden: The Yellowstone National Park.
Hayden: U. S. Geological Survey of Montana, Idaho, Wyoming and Utah, 1872.
Raynolds: Report on the Exploration of the Yellowstone River.

THE FOLSOM - COOK EXPEDITION (1869)

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

"The question of setting definitely at rest the constantly multiplying rumors of wonderful volcanic phenomena around the sources of the Yellowstone, began to be seriously agitated among the people of Montana as early as 1867. An expedition was planned for that year, but came to nothing. A like result attended a similar effort the following year. In 1869, the proposition came near materializing, but fell through at the last moment, owing to the failure to obtain a military escort. There were three members of this proposed expedition however, who refused to be frightened off by any dangers which the situation at that time promised. They had already provided themselves with an elaborate equipment, and were determined, with escort or without it, to undertake the trip. The names of these men were David E. Folsom, C. W. Cook and William Peterson, the last named being a native of Denmark. Armed with "repeating rifles, Colt's six-shooters, and sheath-knives", with a "double-barreled shot gun for small game", and equipped with a good "field-glass, pocket compass and thermometer", and utensils and provisions"for a six weeks' trip", they set out from Diamond City on the Missouri River, forty miles from Helena, September 6, 1869.

The route lay up the Missouri to the Three Forks; thence via Bozeman and Fort Ellis to the Yellowstone River; and thence up the Yellowstone to its junction with the East Fork inside the present limits of the Park. From this point they crossed to the east bank and followed up the river, passing through the many groups of hot springs to be found east of the Grand Canyon. On September 21st, they arrived at the falls of the Yellowstone, where they remained an entire day. Some distance above the rapids they crossed to the west shore and then ascended the river past Sulphur Mountain and Mud Volcano to Yellowstone Lake. They then went to the extreme west shore of the lake and spent some time examining the surpassingly beautiful springs at that point. Thence they crossed the mountains to Shoshone Lake, which they took to be the head of the Madison, and from that point struck out to the northwest over a toilsome country until they reached the Lower Geyser Basin near Nez Perce Creek. Here they saw the Fountain Geyser in action and the many other phenomena of that locality. They ascended the Firehole River to Excelsior Geyser and Prismatic Lake, and then turned down the river on their way home. They were absent on the expedition thirty-six days."

- - -Chittenden: The Yellowstone National Park. pp.61-62.

The first account of the above expedition was published in the Western Monthly of Chicago, in July 1870 "after cutting out some of the most interesting portions of the story, thus destroying in some measure the continuity of the narrative. The office of the Western Monthly was destroyed by fire before the copies of the magazine containing Mr. Folsom's article were distributed and the single copy which Mr. Folsom possessed and which he presented to the Historical Society of Montana met a like fate in the great Helena fire. The copy which I possessed and which I afterwards presented to that Society, is doubtless the only original copy now in existence; and for the purpose of preserving the history of the initial step which eventuated in the creation of the Yellowstone National Park, I re-published in the year 1894, five hundred copies of Mr. Folsom's narrative for distribution among those most interested in that exploration." (Langford: A Diary of the Washburn Expedition to the Yellowstone and Firehole Rivers in the year 1870, pp. lx-xl).

To David E. Folsom really belongs the credit for the "National Park Idea". The members of the Washburn-Doane party while encamped at the junction of the

THE FOLSOM - COOK EXPEDITION (1869) Hall.

Firehole and Gibbon Rivers on September 19, 1870, discussed the disposal of the great area which they had been passing through and whose wonders they had just seen. Self-interest and advancement were uppermost but Judge Cornelius Hedges suggested that this great country should be set aside as a great national park. After much discussion, this suggestion was adopted and the members pledged themselves to the culmination of the project. "After the return home of our party, I was informed by General Washburn, that on the eve of the departure of our expedition from Helena, David E. Folsom had suggested to him the desirability of creating a park at the Grand canon and falls of the Yellowstone. This fact was unknown to Mr. Hedges . . . . . and the boundary lines of the proposed park were extended by him so as to be commensurate with the wider range of our explorations". (Langford: A Diary of the Washburn Expedition to the Yellowstone and Firehole Rivers in the year 1870, pp. xix).

Bibliography:
Chittenden: The Yellowstone National Park.
Langford: A Diary of the Washburn Expedition to the Yellowstone and Firehole Rivers in the year 1870.
Hayden: U. S. Geological Survey of Montana, Wyoming and the Territories, 1871.

U. S. GEOLOGICAL SURVEY OF MONTANA, IDAHO, WYOMING, AND UTAH, 1871.

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

The personnel of the Geological Survey of 1871 wq
The personnel of the Geological Survey of 1871 was as follows: F. V. Hayden, Director; James Stevenson, managing director; Henry W. Elliott, artist; Prof. Cyrus Thomas, agricultural statistician and entomologist; Anton Schonborn, chief topographer; A. J. Smith, assistant; J. W. Beaman, meteorologist; Professor G. N. Allen, botanist; Robert Adams Jr., assistant; Dr. A. C. Peale, mineralogist; Dr. C. S. Turnbull, physician; Campbell Carrington, in charge of zoological collections; William B. Logan, secretary; F. J. Huse, Chester M. Dawes, C. De V. Negley, and J. W. Duncan, general assistants. Mr. Thomas Moran, a distinguished artist from Philadelphia, accompanied the party as guest, to secure studies of the remarkable scenery of the Yellowstone. In addition to the above, there were about fifteen men who acted as teamsters, laborers, cooks or hunters. The greater part of the outfit was obtained from the United States Quartermaster, Colonel C. A. Reynolds, at Fort D. A. Russell, Wyoming Territory. Horses, mules, wagons and all other equipment were placed on freight cars and taken by rail to Ogden, Utah, from which point the assembled Survey began their journey.

The party left Ogden about June first, 1871, passing along the shore of Salt Lake to Willard City, thence through the Wasatch Range to Cache Valley, thence up the valley to the divide, between the waters of the Salt Lake Basin and those of Snake River. They then descended Marsh Creek to the Snake River Basin and Fort Hall. They rested at Fort Hall for two days and then followed the stage road to Virginia Junction. They here left the stage road, taking an old road, and crossed Blacktail Deer Creek near its source, thence down Stinking Water to Virginia City. They crossed the divide eastward to the Madison River, descended the valley about thirty miles, and crossed the other divide to Fort Ellis, at the head of the Gallatin Valley. They left Fort Ellis on July 15th, 1871, and passed eastward over the divide, between the drainage of the Missouri and Yellowstone, to Bettler's Ranch. Here they established a permanent camp, leaving all the wagons and a portion of the party. A careful system of meteorological observations were kept at this locality for six weeks.

From Bottler's Ranch (sometimes spelled Botteler's Ranch, or Boteler's Ranch) they proceeded up the valley of the Yellowstone, surveyed the remarkable hot springs on Gardiner's River, the Grand Canyon, Tower Falls, Upper and Lower Falls of the Yellowstone, thence into the hot spring basin at this point where they prepared charts of all the hot spring groups and continued up the river to the Lake. They were camped on the northeast side of the lake near Steamboat Point on the night of July 20th, 1871. They made a careful survey of the Lake and its surroundings, soundings were made and the greatest depth found to be three hundred feet. The party separated here and Dr. Hayden, together with Messrs. Schonborn, Peale and Elliott proceeded to the Firehole Valley, by way of the East Fork of the Madison; then ascended the Firehole Valley. They made careful charts of the Lower and Upper Geyser Basins locating all the principal springs and determining their temperatures. They then returned over the mountains by way of the head of the Firehole River, exploring Madison Lake and Heart Lake. They then crossed over to the headwaters of the East Fork by way of the valley of Pelican Creek, explored the East Fork to its junction with the main Yellowstone, and returned to Bottler's Ranch, which they reached on August 28th, 1871.

From here, the united party passed down the Yellowstone through the lower canyon to the mouth of Shield's River, to connect their work with that of Colonel William F. Raynolds, in 1860. Dr. Hayden had accompanied the Raynolds Expedition as geologist. From this point they returned to Fort Ellis and the work of the Survey in the park was concluded for the year 1871.

This party contributed the greatest number of place names to points of interest in the park, and these names and discoveries will later be treated individually.

Bibliography: Hayden: U. S. Geological Survey of Montana and Adjacent Territory, 1871.
Chittenden: The Yellowstone National Park.

U. S. GEOLOGICAL SURVEY OF A PORTION OF THE TERRITORIES OF MONTANA, IDAHO, WYOMING, AND UTAH, 1872.

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

This expedition, although under the general supervision of Dr. F. V. Hayden, was for the most part divided into two principal field parties. The first was organized as follows: Dr. F. V. Hayden, director; Adolf Burck, chief topographer; Henry Gannett, astronomer; A. E. Brown, assistant topographer; E. B. Wakefield, meteorologist; Dr. A. C. Peale, mineralogist; W. H. Holmes, artist; Walter B. Platt, naturalist; W. B. Logan, secretary; A. E. Bingham, Joseph Savage and T. O. C. Sloane, general assistants.

The second, or Snake River division was made up as follows: James Stevenson, director; Professor Frank H. Bradley, chief geologist; W. R. Taggart, assistant geologist; Gustavus R. Bechler, chief topographer; Rudolph Hering and Thomas W. Jaycox, assistant topographers; William Nicholson, meteorologist; John M. Coulter, botanist; Dr. Josiah Curtis, surgeon and microscopist; C. Hart Merriam, ornithologist; Campbell Carrington, naturalist; William H. Jackson, photographer; Charles R. Campbell, assistant; Robert Adams, P. J. Beveridge, J. S. Negley, W. A. West, S. F. Hamp, T. B. Brown and S. C. Jones, general assistants; Hon. N. P. Langford, C. S. Spencer and Dr. Reagles accompanied the Snake River division as guests. Mr. William Blackmore of London, England, accompanied the first division from Fort Ellis to the Geyser Basin for several weeks as guest, for the purpose of examining the newly created National Park.

The first division, under the immediate direction of Dr. Hayden, took Fort Ellis as its initial point. They spent several days at this point and at Bozeman purchasing their animals and securing supplies and other outfit. Only two of the men of this division, Dr. Hayden and Dr. Peale had been with the expedition of 1871; to the rest, this territory was entirely new. After completing their preparations, they passed over the divide into the Yellowstone Valley, traversing nearly the same route followed by the 1871 Survey. The Yellowstone River, from the lowercanyon to its source in the Yellowstone Lake, was carefully surveyed. Some of the branches, as the East Fork, were more carefully examined than at any time previously. From the Lake the party passed over the divide into the Geyser Basin of Madison River, and explored that river and its branches to the Three Forks. They then ascended the Gallatin River and examined it to its sources. The interesting canyon of the Gallatin, which is about seventy miles in length, had never been explored previously, and was unknown even to the inhabitants of the lower valley. From the Gallatin Canyon they passed over the divide into the Yellowstone Valley, near the second canyon, and made a more detailed survey of the Snowy or Yellowstone Range, then passed down the valley through the first or lower canyon, and then along the divide between the branches of the east Gallatin and Shields River to Flat Head Pass; thence across the rugged hills to a point about ten miles below the Three Forks, on the Missouri River. They then returned to Bozeman along the base of the mountains on the east side of the East Gallatin Fork. This closed the field work of this party, quite a great deal of which was entirely outside the Park boundaries.

The second party was placed under the general direction of Mr. James Stevenson, whose experience in this wild life for sixteen years, as the principal assistant of Dr. Hayden, gave him great advantages over any one else that could be secured. This party started from Ogden, Utah, surveyed a route to Fort Hall, and there laid in supplies and made the necessary preparations for a pack-train up the unknown region of the Upper Snake Valley. From Fort Hall, this party proceeded up the west side of the Snake River. Two weeks were spent in making a careful survey of the previously unknown Teton Basin. The range of the Three Tetons was carefully mapped. Nine of the party attempted to ascend the highest peak, the Grand Teton. Only two of those succeeded, James Stevenson and N. P. Langford. So far as can be ascertained they were the first two white men that ever reached its summit.

In the summer of 1860 the party under the command of Colonel W. F. Raynolds, to which Dr. Hayden was attached as geologist, camped for several days at the base of this range. They had with them as guide James Bridger, who was more familiar with the western country and the events in its history for the previous fifty years than any living man. He regarded the ascent of this peak impossible, and many of the old mountaineers and trappers stated that it had been attempted many times without success.

both of the parties met on the same day, August 14, 1872, although starting about two months previously from points several hundred miles apart. The Snake River division remained in this basin several days, until supplies could be obtained from Virginia City for the return trip to Fort Hall.

The party then continued its way up the valley of the Madison to its source, and spent some days exploring the different branches of the Snake River and the Madison. There was perhaps no more unknown or more interesting geographical region in America at this time, than this great water divide of the continent. Within a radius of ten miles may be found the sources of three of the largest rivers in America. The general elevation is from 7,000 to 8,000 feet above the sea, while the mountains whose eternal snows form the sources of these great rivers, rise to a height of 10,000 to 12,000 feet. Flowing northward are the numerous branches of the Missouri, Yellowstone and Wind Rivers, which all eventually unite into one mighty stream, the Missouri. To the south are the branches of the Green River, which unites with the Colorado and finally empties into the Gulf of California, while south and west flow the branches of the Snake River, which uniting with the Columbia, pour their vast volume of water into the Pacific.

The exploration of this remarkable water divide proved that the Madison Fork had its source in a small lake not hitherto noted on any map, and that the so-called Madison Lake belonged entirely on the Pacific Slope. This latter lake was found to be about twelve miles long and eight miles wide. From this body of water flows a stream nearly one hundred feet wide, which, after a distance of about five miles, empties into a second lake which is four miles long and a half mile wide. The former of these lake was named Lake Shoshone, and the latter Lake Lewis, in honor of the great pioneer explorer of the northwest, Captain Merriweather Lewis. The lake now known as Shoshone Lake has at previous times been known as Madison Lake, De Lacey's Lake and Lake Bessie, having been erroneously located by different geographers and mapped according to tradition instead of by actual location.

At the upper end of Lake Shoshone a new geyser basin was discovered, with from seventy-five to one hundred springs, many of them geysers of considerable power. This party regarded the ornamentation about these springs as more interesting and elaborate than those in the Firehole Basin. The divide between the Yellowstone Lake and Lake Lewis was found to be about 50 feet above the former, and 200 feet above the latter. Dr. Hayden, in common with many others, disbelieved the story prevalent among the trappers of the famous "Two-Ocean Water" and states "This low ridge" (the divide between Lake Yellowstone and Lake Lewis above referred to) "in the great water divide of the continent has doubtless given rise to the story of the Two Ocean River, and such a stream has found its way to most of our printed maps". Although the fact of its existence was asserted and stoutly maintained by Bridger for many years prior to the discovery of the Park, it was generally disbelieved until Captain Jones crossed the Pass in 1873. Captain Jones directed an expedition through the "impassable barrier" of the Absaroka Range and verified the traditional "Two-Ocean Water" between Atlantic and Pacific Creeks, in Two-Ocean Pass. This lies some twenty miles above the head of Bridger Lake.

From the summit of Red Mountain, named by the Mount Sheridan, the party were able to encompass within their vision a radius of one hundred and fifty miles. Dr. Hayden says "four hundred and seventy mountain peaks worthy of a name could be distinctly observed. The area that could be swept by the eye from this point could not have been less than fifty thousand square miles, embracing every variety of grand and beautiful scenery, of mountain and valley, probably without a parallel on the continent. Ten large lakes and several smaller ones were embraced in the view, and the entire Yellowstone Park was spread out under the eye. To those who are familiar with the remarkable purity of the atmosphere in these high latitudes"(altitudes?) "these statements need not appear incredible. To the East the Wind River and Big Horn Ranges, with the snow-clad summits of Fremont's, Union and Cloud Peaks, bounded the view. On the north the Yellowstone Range with Emigrant Peak and many of the loftiest mountains in Montana were clearly seen. To the west the numerous ranges comprised in what are called the Salmon River Mountains of Idaho form the horizon of vision in that direction, while the mountains near Fort Hall and the Wahsatch Range completed the mighty ampitheatre. This remarkable view embraced a large portion of Wyoming, Montana, Idaho and Utah Territories." (Hayden: Sixth annual Report of the United States Geological Survey of the Territories embracing portions of Montana, Idaho, Wyoming and Utah, p. 5)

U. S. GEOLOGICAL SURVEY OF A PORTION OF THE TERRITORIES OF MONTANA, IDAHO, WYOMING AND UTAH, 1872. Hall.

The Survey carefully examined about forty small streams which unite and form the upper portion of the Snake River and then proceeded down the valley of the Snake River, through its remarkable canyons, examined Jackson's Lake and the numerous streams that empty into the main river on either side. About the middle of October, 1872, the party arrived at Fort Hall and was soon after disbanded.

* * * * * * * * * * * *

FIRST ASCENT OF THE GRAND TETON BY WHITE MEN.

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

The Teton Mountains form the most striking range in the entire Rocky Mountain region. The French trappers gave them the name of Les Treis Tetons or Three Tetons because from certain points of view the three outstanding peaks bore a fancied resemblance to the human breast. This name was general throughout the west; in Irving's "Astoria" alone do we find any reference to another nomenclature when on page 236 he sets out "These remarkable peaks are known to some travelers as the Tetons; as they had been guiding points for many days to Mr. Hunt, he gave them the name of Pilot Knobs", and Pilot Knobs they remain to the end of the book. However, the name seems to have remained between the covers of Mr. Irving's book as it is used nowhere else. Chittenden says, regarding the name of Teton "The name is now nearly a century old and has passed into all the literature describing that country, particularly that of its fur trade era, the most romantic and fascinating in western history. Indeed it has become the classic designation of the most interesting historic summit of the Rocky Mountains. That it should always retain this designation in memory of the nameless pioneers who have been guided by it across the wilderness and many of whom have perished beneath its shadow, would seem to be a self-evident proposition. Individual merit, no matter how great, can never justify the usurpation of its place by any personal name whatever. An attempt to do this was made in 1872 by the United States Geological Survey who rechristened it Mount Hayden. The new name has never gained any local standing, and although it has crept into many maps, its continued use ought to be discouraged. It is greatly to the credit of Dr. Hayden that he personally disapproved the change, so far at least, as very rarely, if ever, to refer to the mountain by its new name". (Chittenden: The Yellowstone National Park, p. 107). Mr. Chittenden makes the error of supposing that the U. S. G. Survey attempted to rechristen the whole range. They only gave the name of Mount Hayden to the highest, or Grand Teton, which was first scaled by white men on July 29, 1872. Hayden states that eleven of the party commenced the ascent, but Langford only refers to nine. The complete roster is not known, but among the number were James Stevenson, N. P. Langford, Frank H. Bradley, Gustavus Bechler, S. F. Hamp, C. S. Spencer and W. A. West. Messrs. Stevenson and Langford alone reached the summit. Mr. Bechler received a severe sprain which made it imprudent for him to attempt the steeper slopes and he turned off and examined the Grand Canyon for a mile or so. Dr. Bradley, Hamp and Mr. Spencer reached the saddle. Dr. Bradley engaged in the great game of "passing the buck" to explain his failure to reach the top. He says, "Here" (on the saddle) "I stopped at 12 o'clock, at the elevation of about 11,400 feet, to wait for a mercurial barometer, which Mr. West had undertaken to deliver to me at that point, so that I might take it to the summit. I afterward learned that he had already turned back from the high spur, without really attempting either to reach the saddle himself or to send forward the barometer by any other person . . . . . I waited longer than I should have done for the missing barometer, and found that time would not permit me to complete the ascent". (Report of Frank H. Bradley, Geologist of the Snake River Division, p. 220-222). Dr. Bradley states later that "the hardest part of the ascent is past when the high saddle is reached, which does not satisfactorily explain why Messrs. Hamp and Spencer failed to reach the summit by only three hundred feet.

FIRST ASCENT OF THE GRAND TETON BY WHITE MEN. Hall.

The following is Mr. Langford's own story of the ascent:

"We carried out the intention, with which we started, of visiting and properly locating the three Tetons, and of ascending to the summit of the highest of them. Assured by our guide, and others who had long been familiar with the country, that it would be impossible to clamber up this mountain, that though repeatedly attempted it was a feat which had never been achieved, we did not undertake the task without great misgivings as to the result. The most northerly, or Grand Teton, which has received the name of, and will hereafter be known as, Mount Hayden, presents to the eye an outline very similar to that of the Matterhorn in the Alps. Its very appearance, unlike that of most of our mountains, seems to forbid all attempts to scale it, and for the most of the distance the ascent can only be accomplished by climbing with both feet and hands. The face of the mountain presents an angle never less than 45° and frequently 60°, much more abrupt than the steepest stairways. Glaciers of greater and lesser dimensions are met with every few hundred feet, and in several instances they proved almost insurmountable. The irregular stratifications of the rocks were often such as to leave us with no support other than our hands at points and turnings where a failure in our hold would have precipitated us hundreds of feet down the face of the mountain. At one or two points when nearing the summit we would have been obliged to abandon the task but for the aid we received by casting a rope over prominent projections and pulling ourselves over them, to places where we could obtain secure footholds. In one of these efforts, Mr. Stevenson came near losing his hold and falling down a precipice nearly a thousand feet. Another of our company, while ascending along the edge of a glacier, losing his hold, slid down a smooth ridge of ice, a distance of forty feet, with fearful rapidity. His own presence of mind, in hastily throwing himself astride the edge of the glacier and descending it in that position, caused him to fall into a snow-bed at the bottom, and on the extreme edge of the precipice. This saved him from falling at least 800 feet. Of nine of the company who commenced the ascent Mr. Stevenson and myself were alone successful.

We found on one of the buttresses, a little lower than the extreme top of the mountain, evidence that at some former period it had been visited by human beings. There was a circular inclosure about seven feet in diameter formed by vertical slabs of rough granite, and about three feet in height, the interior of which was half filled with the detritus that long exposure to the elements had worn from these walls. It could not have been constructed less than half a century ago, when Indians only inhabited this region. The summit of the Teton is very small, not more than 30 by 40 feet in diameter, with a precipitous descent on all sides. Its height, by triangular measurement is 13,833 feet. The view from it embraces the valley of the Snake River and territory contiguous, over a diameter of at least one hundred and sixty miles. For grandeur, vastness, and variety, it is nowhere excelled in the region of the Rocky Mountains.

On our descent of the mountain, while yet at a height of 10,300 feet we crossed a lake, 600 yards long by 200 yards wide, of perpetual ice, which in thickness was about three feet, not unlike in character the descriptions given of the most elevated glaciers of the Alps." (Report of N. P. Langford on the Resources of the Snake River Valley, included in Dr. Hayden's Sixth Annual Report, pp. 89-90.)

Dr. Bradley states in regard to the altitude of the Grand Teton that "the reported reading of Mr. Stevenson's aneroid gives the elevation of the peak as 13,400; but the gradienter measurements, taken by Mr. Hering, indicate an elevation of 13,858 feet, which has been adopted as altogether the most reliable determination."

A curious piece of natural history is related by Dr. Hayden in connection with the ascent of Mount Hayden, but is not referred to by Mr. Langford: "At certain seasons of the year, usually in August and September, the air is filled to a great height with grasshoppers flying in every direction. They sometimes rise to the height of many thousands of feet. As they passed over this Teton Range they became chilled and dropped on the snow and ice in vast numbers and gradually melted the snow, so that the myriads of little holes which they formed gave to the surface a peculiar roughness. It was due to this fact that Messrs. Stevenson and Langford were able to cling to the almost vertical icy

sides of the peak and complete the ascent." Dr. Bradley bears out this view on page 219 of his report: "In passing over the drifts, we found many grasshoppers lying motionless and apparently frozen, in small pits in the surface from two to three inches deep, the snow having apparently been melted from beneath them by the heat of their bodies. As the sun got higher, however, they were soon thawed out, and became as active as any of their race."

As far as is known, this peak was not ascended again until 1898, when Messrs. William Owen, Frank S. Spaulding, John Shive and Frank Peterson attained the top. It was not ascended again for twenty-five years, when in 1923, two parties reached the summit within two or three days of each other. Several ascents have been made since, notable among which are two made in the summer of 1926 by members of the Sierra Club while on their annual Pilgrimage.

* * * * * * * * * * * *

TRUMAN C. EVERTS

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

"The most extraordinary instance that has come under my notice of a man being lost for a length of time and surviving, occurred in this very Yellowstone country.

"From a detailed account of his adventures, written by himself and published in Scribner's Magazine, it appears that in August, 1870, Mr. Everts, formerly United States assessor for Montana, joined a numerous company about to visit the Geyser region. One day, while the party were with difficulty unravelling their way through the thick forests, and the members of it had all scattered out in search of a practicable path, Mr. Everts strayed so far away that he lost touch of his companions altogether. It was late, and being unable to rejoin them he was compelled to camp out alone that night. This occurred close to the lake.

"The next day, Mr. Everts resumed his search, and seeing, as he thought, some indications of a trail, he dismounted to examine the ground more carefully, and neglected to secure his horse. Something or other happened to scare the animal, and, his attention attracted by a crashing in the brush, Mr. Everts looked up just in time to catch a glimpse of his horse disappearing through the trees. The loss of his horse was in itself a terrible disaster; but that was not all, for on the saddle were his gun, matches, blanket, fishing tackle, and all other appliances which render a man comparatively safe and self-supporting in the wilderness. He never saw the horse again, and for thirty-five days after that fatal parting this unfortunate gentleman wandered alone, through woods and over mountains, totally unarmed, and with no other instruments or appliances than two knives and a pair of small field-glasses. Strange to say, he allowed himself almost to perish daily, for want of fire, for nearly a fortnight, before he thought of kindling one by means of the lenses of his glasses. One of the fearfully cold storms which suddenly arise in these latitudes came once, and he would have succumbed to cold and exposure had he not managed to reach a group of hot springs. As it was, he was severely frosted on both feet. In that neighborhood he remained for seven days, keeping himself warm by lying on the hot incrustation surrounding a little boiling spring, in which he cooked an insignificant supply of roots.

"The day before his rescue he lost his glasses also; an additional misfortune which nearly overthrew the slight remnant of life and reason which still held out against the fatal effects of his prolonged and unparalleled sufferings. At an earlier stage of his adventures he had even lost his knives. In fact, after commencing with his horse, he lost everything of use that he had with him; and the only marvel is that he did not lose his head also, and his life.

"As he had become separated from the outfit on a peninsula of the Yellowstone Lake, round which they were making their way, Mr. Everts took a direction which he thought would cut across this peninsula at right angles, and bring him out on the shores ahead of the party. He did emerge upon the sandy beach of a lake; but it was not the lake he was searching for; it was another sheet of water altogether.

"Here he found some edible thistles, and tasted food for the first time in four days; and upon an exceedingly scanty supply of these roots, grass and leaves, he managed to subsist for thirty-one days more. The only animal food that he contrived to get consisted of one wretched little fowl no bigger than a snow-bunting, which, as it was benumbed with cold, he succeeded in capturing, and the tip of a sea-gulls wing which he picked up. It strikes one as very singular that he could not snare or kill with sticks and stones something in the shape of squirrels, birds, mice, or badgers. But it is easy to talk when one is not in a fix at all, and to think of all the ingenious contrivances one would have invented. When it comes to the point, I dare say the captious critic of his actions would starve as soon as anybody else. I don't want to try it at any rate. I have no doubt an old mountain man would have procured food somehow; but Mr. Everts must have been entirely unaccustomed to a wild life, else he never would have lost his horse, left his rifle on the saddle when he dismounted, or gone without a supply of matches in his pocket. This, however, adds much to the interest of his story, and enhances the marvellousness of his escape.

"While waiting at the hot springs for fine weather, he manufactured a knife out of the tongue of a buckle, and made a fishing line and hook out of some red tape and a pin. This is probably the only instance on record of red tape proving of the slightest use to anybody. He subsequently lost all of these articles in a forest fire. He tried to make another fish-hook out of the rim of a pair of broken spectacles, but failed. Mr. Everts was certainly the most unfortunate man that ever was lost. Everything that could happen to him did occur. His feet were badly frozen; he lost all he had originally, and everything that he made; he even got rid of one of his shoes; he slipped into some boiling water and scalded his hip severely; and it was apparently his nightly custom to tumble into the fire and burn himself. He left the group of springs on the eighth day, and returned to the lake. Here he stumbled on the camping ground of his party, and found an old baking-powder tin and a fork. He did not attempt to follow the trail, but started in the right direction for Bozeman. He made but little progress and wandered for many days, gradually becoming weaker and weaker, until he was discovered in the last stage of exhaustion, about seventy miles from Fort Ellis, by two men who had been sent out to hunt for him. One of them started immediately for medical assistance from the Fort, while the other remained with Mr. Everts, who in two days was capable of being moved to a miner's cabin twenty miles distant. But there he nearly perished, for though the miners most carefully tended and watched him, and did everything in their power to alleviate his sufferings, they had not the medicines necessary for his condition. A thirty-five days' diet on tough fibrous roots had completely arrested all the digestive functions of his body, and he would most undoubtedly have died had not an old hunter and trapper happened to pass by. This man, who had probably been many times starved himself, knew exactly what was the matter, and fortunately he had also the means of overcoming the evil. From the fat of a bear he had recently killed he tried out a pint of clear oil, and administered the draught to Mr. Everts. This had the desired effect, and rest and good food completed the cure. I envy Mr. Everts the strength of his brain. How he contrived to go entirely and irrecoverably mad I cannot imagine. His understanding must be strong indeed. Comparatively early in his wanderings he experienced, to use his own words, 'one of those strange hallucinations which many of my friends have misnamed insanity, but which was to me providence.' An old clerical friend seemed to appear to him, and authoritatively ordered him to take a certain direction. Reluctantly, for it was quite contrary to his own convictions, he followed the advice of his ghostly companion, and was saved; but whether or not, he could have succeeded in carrying out his own intention of crossing the mountains to Virginia City, it is of course impossible to say.

"Later on his mind became much affected. The different members and positions of his body segregated themselves into separate and distinct individualities and identities, who accompanied him as companions, and with whom he, to his great satisfaction, kept up a constant conversation. Yet during this time he was able to reason consistently and sensibly about his condition, the route he ought to take, and his chances of winning out, and to think perfectly nat-

urally of his home ties and affections. Altogether it is a wonderful history, and one worthy of notice, as exemplifying what an incredible amount of hardship, cold and starvation the human frame is capable of enduring, and showing what apprently insurmountable obstacles and difficulties a man can overcome, if only he can manage to retain even a partial mastery over his mind and reason." - - - - Earl of Dunraven: The Great Divide, pp. 246-261.

* * * * * * * * * * * * *

THE INDIANS OF THE YELLOWSTONE COUNTRY

By Charles Phillips
1890 - 1927

While Yellowstone Park lies in the very heart of the "Indian country" it probably had a smaller Indian population than any other region of like area in the United States. It has been customary to ascribe this sparsity to the fear on the part of the aborigines toward the super-natural elements of the Park landscape, but as Chittenden has pointed out, their neglect of the Park area undoubtedly rested on more practical grounds. The region was difficult of access and still more difficult to travel in. The lack of drinking water in many places made it an unsuitable camp ground in summer and the great depth of snow rendered it wholly uninhabitable in winter. A weightier reason but one that is less comprehensible when the Yellowstone is the last stand of many of the larger animals, is the fact that in Indian days it was far surpassed as a hunting ground by the surrounding lower country.

Still it was not wholly unknown to the surrounding tribes and was even the home of a hermit-like branch of the Shoshone stock, the Sheep-eaters or Tukuarika. They were a weak and degenerate race, wholly unfitted to hold their own with their more vigorous neighbors and found the inaccessibility of the region a protection that out-weighed its undesirability as a residence. For the same reason the rather peaceful Bannocks who lived in constant terror of the war-like Blackfeet preferred to travel across the Park to the buffalo country rather than take the easier northern route via the Gallatin River and Bozeman Pass. The chief attraction within the Park boundaries apparently was the obsidian that was quarried at the cliff of that name. This material was a favorite for arrowheads and implements for it was easily worked and took a keen edge. The quarry was much visited by neighboring tribes and even more so by the resident Sheep-eaters with whom obsidian seems to have been an article of barter with their neighbors.

Before discussing in detail the several tribes whose history is associated with that of the Park we can secure a better perspective and avoid repetition by establishing their relation with the various tribes of the entire continent. The native races may be classified along two lines, i.e., by language and by cultural affinities. The first is the more vital for it approximates more closely the blood relationships, but the latter is often more useful in describing their habits and customs.

The Bureau of American Ethnology recognizes more than fifty distinct linguistic families or stocks north of Mexico. Of these perhaps the best known are the Algonkian, Iroquoian, Muskhogean, Caddoan, Athapascan, Salishan, Shahaptian, Siouan and Shoshonean. Of those named the first and last three are associated with this region.

The Algonkian stock occupied a greater area than any other in North America; their territory stretched from the Atlantic to the Continental Divide. Several Algonkian tribes are among the best known in American history, notably those in New England who came in contact with the Pilgrims and Puritans, the Mohicans of whom Cooper wrote and the Powhatans of Virginia. In the middle west the Objibwa (Chippewa), Miami and Sacs and Foxes were perhaps the best known. The far western Algonkian tribes are usually regarded as the most typical of the Plains Indians. They were the Cheyenne, the Arapaho and the three divisions of the Blackfeet. Of these the Blackfeet and Gros Ventre, related to the Arapaho but allied to the Blackfeet, are most closely connected with the Yellowstone country.

The Siouan stock was second only to the Algonkian in point of numbers, but the territory they occupied was much less. Their center of abundance was from the Mississippi almost to the Rockies; five states take their names from Siouan tribes, North and South Dakota, Iowa, Kansas and Missouri. The best known were those of the Dakota federation (the Sioux proper). The Mandans with whom Lewis and Clark spent the winter of 1804-5 were the most advanced in adriculture and industrial arts. It is with the Crows, however, who occupied the region immediately east of the Park between the Absaroka and Big Horn Mountains that we are chiefly concerned.

The tribes living west and south of the Park as well as the aboriginal inhabitants of the Park itself, the Bannocks, Wind River Shoshones and Sheep-eaters, respectively, were members of the Shoshone linguistic family. This widely distributed stock showed a greater diversity of culture and habits than any other on the continent. The majority of its members, especially those tribes occupying Utah, Nevada and southern California were far below the standards of the typical red man in culture and prowess. The Comanches of Texas, however, were not excelled by any of the Plains Indians for war-like valor while the nearly related Aztecs of Mexico attained a civilization only a little below that of the Incas of Peru and the Mayas of Central America.

Before speaking of the Agriculture of the various tribes it may be remarked that this side of the Indians nature is decidedly below his spiritual and ethical standards; with the Eskimos the situation is just the reverse. The Indian has a relatively conservative type of mind. He has great powers of endurance and patience and also of action if stirred by a crisis but is lacking in originality and inventiveness. The various types of culture found among the native tribes is not related to their racial or linguistic affinities but rather to their environment. The living conditions of a definite region tend to produce a resemblance in the habits and customs of the peoples within it, irrespective of their blood relationships. On this basis, the Indians north of Mexico have been grouped in eight characteristic areas, (1) The Eastern Woodland Area, (2) The Southeastern Area, (3) The Plains Area, (4) The Plateau Area, (5) The Southwest Area, (6) The California Area, (7) The North Pacific Area and (8) The Mackenzie River Area. The Indians whose homes surrounded the Park are all of the Plains type. The proximity of the Plateau Area on the west influenced the Bannocks markedly while the Nez Perces may be regarded as intermediate between the two types.

The Plains Indians are so-called because their distribution coincided with the limits of the treeless prairies known as the Great Plains. Differences in environment within this vast area led tofurther differentiation and we may regard the typical Plains tribes as comprising four geographical groups. The following list of the larger tribes will demonstrate that the Indians of this area are undoubtedly the most prominent of all in American history and literature.

(1.) Northern Tribes - Blackfeet, Gros Ventre, Assiniboine, Teton-Dakota, Crow.
(2.) Southern Tribes - Arapaho, Cheyenne, Comanche, Kiowa.
(3.) Eastern Tribes - Santee - Dakota, Pawnee, Mandan, Arikara, Osage.
(4.) Western Tribes - Bannock, Northern Shoshone (Snake), Wind River Shoshone, Utes and Nez Perces.

The outstanding characteristics of the Indians of the Plains was their association with the buffalo. Not only did they depend on the buffalo for food, clothing and shelter but the animal played a conspicuous part in their mythology and religious life. The flesh of the buffalo was the great staple in their diet although other game was frequently used. Such roots, seeds, fruits and berries as could be ontained locally were also eaten but in limited quantities. Among the Indians of the northern Rockies the most important vegetarian element in their food was the root of the camas. With the exception of the cultivation of a native tobacco agriculture was practically unknown in the early days among the more typical tribes of the Plains.

The chief weapon both in hunting and in war-fare was the bow and arrow. Even the introduction of the rifle did not wholly supersede the earlier weapon in buffalo hunting for the latter had the advantage of being noiseless as the hunter rode among the herd shooting down his victims. Arrow-heads were originally of stone; later scraps of iron were used or better, a broken knife blade. The Indians bow was shorter than the English "long bow" and the technique of handling it quite different. Lances and stone headed clubs

("tomahawks") were important weapons of war and to a lesser extent, of the hunt.

The introduction of the horse from Mexico between 1750 and 1800 made a profound difference in the habits of the Indian, especially the nomadic Plains tribes who spent their lives following the buffalo herds. No sort of wheeled vehicle was known; instead a contrivance known as a travois was used. It consisted of two long poles fastened together at one end over the horse's shoulder with the other ends dragging one on either side like a huge V. The load was lashed across the poles behind the animal. The travois was often constructed especially for the purpose but was more often improvised from the teepee poles and cover. Before the introduction of the horse a smaller travois was used for dogs, the only aboriginal beast of burden. The dragging ends of the travois poles made even deeper ruts than carriage wheels, a fact that accounted for the well-marked character of trails that were used only seldom. There was practically no water transportation on the Plains and the canoe was unknown. In fact, many of the tribes had a superstitious dread of large bodies of water and avoided them. Streams were usually crossed by swimming the loaded horse over.

One of the most characteristic features of the culture of the Plains Indians was the teepee, the conical skin tent that has been described as the most perfect portable habitation devised by man. Its most ingenious feature was the ventilating feature that permitted an open fire within. However, the teepee (often incorrectly called "wigwam" which was an entirely different structure) is too familiar to require description. There were many differences in teepee construction that often served to identify a distant encampment. Thus, in setting it up some tribes, including the Blackfeet, Crow, Bannock and Shoshone, used a four pole foundation which tended to group the projecting ends of the lodge-poles in a somewhat rectangular pattern. Others, among them the Gros Ventres and Nez Perces, used a "three pole tie" that gave the poles a spiral appearance. Again, the Crows used very long teepee poles and the Gros Ventres set up their lodges with an exceptionally narrow base.

A distinguishing trait of the Plains tribes was the almost complete absence of weaving among them and the use of leather in place of textiles. For that reason the women of the Plains attained a higher degree of skill in the tanning and dressing of hides. Leather was put to innumerable uses; garments, foot-wear, teepee-covers, a wide variety of bags, pouches and cases (parfleches), saddles and bridles, handles for tools and weapons, thongs for splicing and lashing in place of nails, etc.

The clothing of the men varied widely with climatic conditions. In midsummer they often wore nothing more than a breech cloth and moccasins; in winter the northern tribes wore a decorated shirt and a pair of long leggings (not unlike the modern "chaps"). A robe of an entire buffalo hide, including the tail, was used at all seasons, both on ceremonial occassions and for warmth. The womens' garments were more uniform among the different tribes and varied less with the season. The typical garment was a long, sleeveless, one-piece dress that reached a little below the knees. Knee-length leggings completed the costume, altho additional clothing might be worn if required for warmth.

The social organization of the red man was based on a sort of indefinite communism. Ownership of the land was incomprehensible to the Indians and in early days the property of the well-to-do was regarded as being more or less at the disposal of the more unfortunate members of the community. Contact with the white man developed a more definite property sense and among the Plains Indians the number of horses owned became an index of wealth. In no case, however, did wealth confer much social distinction. The aristocrats of the tribe were the wise men and those with brave or charitable deeds to their credit; less often, those with oratorical ability and real or supposed psychic power. Valor in war out-weighed all other considerations and there was a complicated system of grading honors in battle.

The political organization was equally loose. It was for the most part quite democratic and hereditary leadership was rare. Usually each band had a council of older men, one or more of whom was recognized as chief. The strength of a man's leadership depended solely on the degree in which he enjoyed the confidence of his people; occassionally a powerful leader would

rise to the chieftanship of the whole tribe. The "war chiefs", often young men, were leaders of military parties the size of which was determined largely by their own prestige. In a crisis the "war chief" might temporarily supersede the tribal chief, who was as likely to be chosen for his skill in council as his military ability. Mention should also be made of the fraternal organizations or secret mens' societies of limited membership that existed in every tribe and had a political as well as social significance, usually of a police nature. These societies embraced every age from youth to old manhood and a man passed from one to another as he matured. They had a complicated ritual and were in many respects comparable to the modern fraternal order.

While the Indian is of an intense spiritual nature his religious concepts did not progress beyond a very primitive nature worship. It is true, however, that among many tribes there was an indefinite groping toward monotheism in which the sun usually symbolized the supreme power. The forces of nature, the thunder, lightning and the four winds, naturally had a supernatural significance and their mythology is full of personifications of animals and imaginary creatures like the thunder-bird and various water monsters. The Plains Indians had, in addition, a more local religious institution, the so-called supernatural helper. It was customary for a youth on reaching maturity to retire to a secluded spot and there fast and pray until he obtained his "dream" in which the vision designated his personal medicine objects and taught him the songs and formulae that would secure him supernatural aid in time of need. A further development was the medicine bundle containing the sacred objects of the tribe which were seldom opened and used only in connection with the most solemn ceremonies.

Such a complicated religious life naturally resulted in innumerable ceremonies which usually took the form of dances. Among the Indians of the Plains the most important of these was the celebrated Sun Dance. It was given by either a man or a woman in fulfillment of a vow taken in time of danger or distress and was participated in by the entire tribe. It reflects the sun-worship common on the Plains and has an elaborate ritual extending over several days. Originally the ceremonies were accompanied by various forms of self-torture and laceration and for that reason the dance was prohibited by the white authorities. Of late years, however, an expurgated form is being permitted on some reservations.

The Ghost Dance is more recent and far more dangerous from a disciplinarian point of view. It originated among the Paiutes of the Plateau Area about 1888 and spread rapidly over the Plains. It teaches the coming of an Indian Messiah who will raise the dead, drive out the white man and restore the buffalo. The dance was eventually suppressed but not before it led to several out-breaks.

The foregoing remarks apply equally to all the four tribes surrounding the Park, the Blackfeet, Crows, Shoshones and Bannocks, and to a lesser extent to the resident Tukuarika. Let us now consider some of the tribal characteristics of each.

The term Bl ckfeet is popularly applied to all three tribes of the so-called Blackfeet confederacy and occassionally to their allies, the Gros Ventres and the Sarsi. The three affiliated tribes were, (1) the Blackfeet proper, called by themselves Siksika ("black feet" , supposed to refer to the discoloration of their mocassins by the burnt over prairie), (2) the Bloods or Kainah (many chiefs) and (3) the Piegans or Pikuni ("those with badly made robes"). These three tribes, together with the Cheyenne and Arapaho, constituted the western division of the Algonkian stock.

The confederacy held most of the territory on the flanks of the Rockies from the Musselshell River to the North Saskatchewan River in Canada. The center of distribution of the Blackfeet proper was along the North Saskatchewan, of the Bloods along the South Saskatchewan, and of the Piegans on the headwaters of the Missouri north of Three Forks. They are known to have lived at one time farther southeast and may have migrated from the Red River of the North with the Cheyenne and Arapaho. Of the three tribes the Piegans were nearest the Park and it was their war-parties that were most often encountered in the

Park area. The country between the Musselshell and Yellowstone Rivers constituted a "no-man's-land" between them and the Crows and was claimed by both tribes.

The Blackfeet were an agressive and predatory people, at war with all their neighborsexcept their allies and these were regarded with suspicion. They were in perpetual conflict with the Sioux, Crows, Assiniboines, Crees, Snakes, Flatheads and Kootenai, but had met on the war path practically every tribe in the west in their rovings. They never waged an organized war against the United States but probably killed more whites than many tribes that did, by their systematic "potting" of every stranger from ambush.

In stature the Blackfeet were above average height although they were exceeded by several of the Plains tribes who, as a group, were the tallest of American Indians. In complexion they averaged lighter than the normal copper-red of the race; many of the men inclined toward a yellow-brown while some of the women were nearly white. The facial features of the Blackfeet were more delicately cut than many tribes; their physiognomy, while typically Indian, had the characteristic features such as high cheek-bones and acquiline nose only in a moderate degree. It is interesting to note in this connection that the Indian on the "buffalo nickel" is a blackfoot, Two Guns White Calf, the son of the last chief of the Piegans.

All the Blackfeet have a high sense of dignity and personal honor. Many of them are wonderful orators and the bearing of the old men is truly kingly. Their racial pride is extraordinary and they regard with considerable satisfaction the reproach that they are the least civilized of all the major tribes.

Allied to the Blackfeet were the Gros Ventres who present an interesting transitional type of culture. This title is the French-Canadian form of the name by which they were generally known, "big bellies", in reference to their reputed appetites. They lived chiefly between the Musselshell and Milk Rivers although many ranged farther north.

The Gros Ventres or Atsina are a division of the Arapaho who became detached from the mother tribe several centuries ago. In temperament, however, they are much nearer their allies than the parent stock. The Arapaho are a mild and genial people altho not outdone in bravery by their more war-like neighbors. They are kindly and accomodating and their art and religious ceremonies highly developed. The Gros Ventres, on the other hand, fairly out-Blackfoot the Blackfeet themselves in restlessness and chronic hostility. They kept up continuous relations with the Arapaho in Colorado and it was on these inter-tribal visits which took them frequently through this part of the Rockies that they perpetrated many of the outrages that were incorrectly ascribed to the Blackfeet.

The English name of the Crows is a translation of their own designation for themselves, Absaroka, and the range of mountains by that name will remain a monument to the tribe after they have gone the way of the red man. Their ancestral home was the valley of the Big Horm River altho in summer they ranged well up on the east slope of the Absarokas and the west slope of the Big Horns. Northward they extended to the Yellowstone River and sometimes to the Mussellshell. They were the north western tribe of the great Siouan stock and were closely related to and, in fact, at one time part of the Hidatsa who later became affiliated with the Mandans.

While the Crows were not of a predominantly war-like disposition they had several hereditary feuds, notably with the Blackfeet and Snakes, that occupied much of their time. With the whites they were uniformly friendly, altho they affected to despise the paler race and never over-looked an opportunity to plunder them. They were the chief reliance of the early fur-traders and the Crow country was always a refuge when neighboring tribes were in a mood to vent their grievances against the white man. It will be remembered that it was the Crows who befriended Colter and accompanied him as far as Jackson Hole on the expedition on which he discovered the Park region.

Physically the Crows were a fine race. Next to the Cheyenne they were the tallest of the Plains Indians. They were extremely fastidious in their personal appearance and were famed for the beauty and quality of their clothing and personal equipment. The unusual length of their hair was a metter of pride with them and they devoted much time and many pains to its care.

As a people they were clever rather than intellectual and were somewhat lacking in strength of character. Their commercial sense was keen and their tongue became a sort of trade-language even among hostile nations. It may be added that no tribe was more adept at the sharp practice prevalent at that period. They were noted for two qualities, their horsemanship and skill in stealing. These two virtues were often associated ; as has been said they were great lovers of the horse no matter to whom the horse belonged. Among other short-comings they were extremely superstitious and had a proud superciliousness that made them disagreeable associates, while their dissolute nature and other dubious morals stood out in contrast to the generally high standards of the Indians of the Plains.

The name Wind River Shoshone is misleading for while the valleys of the Wind and Green Rivers were the center of their distribution, the territory held by the tribe comprised most of western Wyoming. The origin of the term"Shoshone" is unknown; it does not occur in their own language altho they recognized it as applying to themselves. They were the eastern-most division of the Shoshone proper, better known to readers of western stories as the Snakes whose ancestral home was the valley of the great river in Idaho that bears their name. They were not as nomadic as the more typical Plains tribes and even the Wind River Indians were probably less familiar with the Park area than many more distant nations.

The Shoshone were unagressive and rather timid by nature. For that reason they were the favorite object of pillage of practically every tribe from the Missouri to the Columbia. Even the closely related Utes could not resist such a sure fire proposition. This temperament, on the other hand, made for excellant relations with the whites. The Shoshone soon learned that the white man made a more effective ally than the red and they took an active part as scouts in many of the Indian Wars.

Measured by Indian standards the Shoshone were rather slight in physique and few were above middle stature. Their features lacked the powerful lines of the Plains types and were for that reason often more agreeable from a civilized point of view. Their mental characteristics as well as their culture showed the influence of the neighboring Plateau Area.

The recent history of the Wind River Shoshone is so bound up with that of Washakie, their chief for half a century, that a short account of him will serve for the entire tribe. Washakie's prestige rested largely on his warlike prowess and aggressive administration, traits so uncharacteristic of his people that they must be accounted for by the admixture of Umatilla blood in his veins. His valor against his traditional tribal enemies was excelled only by his friendship toward the whites. From the days of the 49'ers who remembered Washakie and his people for their friendly aid and helpfulness, the chief never lost sight of the fact that the future of the tribe lay in amicable relations with the whites and worked unceasingly toward that end. The eastern Shoshone are now on a reservation on the Wind River north of Lander where they live on the best of terms with their ancient foe, the Arapaho, and their daily life and frequent tribal festivities are a feature of the trip to the south entrance of the Park.

The Bannocks, a second division of the wide-spread Shoshonean stock had a closer association with the Park than any of the three former tribes. By language they were related to the Utes of Utah and Nevada but they were united more closely to the Snakes through extensive intermarriage. They were a more spirited and enterprising people than the Shoshone proper and, while always maintaining a friendly attitude, never essayed to help their long-suffering relatives from the raiding parties that came from far and wide to harass them.

The territory of the Bannocks separated that of the Wind River (Eastern) Shoshone from the Snakes or Shoshone proper. There were two divisions of the tribe; the southern occuppied the valley of the North Fork of the Snake River, south of the Continental Divide and west of the Tetons while the northern division claimed the valleys of the three forks of the Missouri although the Blackfeet disputed this claim with considerable success.

The Bannocks were more nomadic than most of their Shoshonean relatives and their habits and customs showed the influence of the various peoples with whom

they had come in contact. For this reason they had acquired many traits of the Plateau Area type of culture, chiefly that of the Nez Perces. Physically they were not unlike the Shoshone proper and this resemblance was strengthened by frequent inter-marriage.

Their roving propensities led them to make excursions to the Plains every summer to hunt buffalo. As previously noted, their wholesome respect for the Blackfeet prevented them from crossing the mountains by the present Bozeman Pass. Instead they chose a more southerly route, one that lay directly across the Park from west to east and was known in the early days as the Great Bannock Trail. The trail started at Henry Lake, a favorite rendezvous of the Bannocks, crossed the Divide by Targhee Pass and entered the Park near the point where the Madison River leaves it. Thence the route was north of Maple Creek and parallel to it, leading to a pass north of Mt. Holmes by which the Gallatins were crossed. The trail dropped down to the headwaters of Indian Creek and followed the creek to its junction with the Gardiner River which was forded just above the present Seven-mile Bridge. The "Norris Road", the first road in the Park, followed the trail from this point to Mammoth. The line of march was past Swan Lake to Snow Pass and down the present saddle horse trail to Mammoth Hot Springs.

The auto road marks the approximate location of the Bannock Trail from Mammoth to Tower Fall; as far as Undine Falls, however, it ran along the Gardiner and Lava Creek at the foot of Mt. Everts. The ford across the Yellowstone River was just above the mouth of Tower Creek; from here to Soda Butte the route was still along the present road. At the latter point it branched, the north fork passing through the Cooke City region and down the Clarke's Fork to its union with the Missouri while the other continued up the Lamar, over the Absarokas and down the Shoshone River to the Big Horn country.

It would seem from the route described that the Indians were at some pains to avoid the geyser regions. They could scarcely have been unaware of them for the more adventuresome individuals would surely wander that far from the trail; moreover, the Norris Basin can be seen from Mt. Holmes which was undoubtedly an observation point for parties passing it.

Though for the most part of a peaceable disposition several escapades of the tribe have required government intervention. The most important occurred in 1877-78 when the Bannocks, excited by the Nez Perce War and driven to desperation by continued encroachments on the part of the whites, left their reservation and inaugurated a"war" that was as futile as it was short-lived. One raid took them within the Park but the only damage was the loss of a few horses. The war was terminated by a battle on the Clarke's Fork northeast of the Park in which the warriors were decisively beaten and the women and children in the neighboring camp all murdered.

There remains to discuss the Indians of the Park itself but concerning the tribe of whom we should like to say the most, we must say the least for lack of definite information. The only permanent residents of the Park of whom we have knowledge was a minor off-shoot of the Shoshone or Snakes. By these latter they were known as Tukuarika of which the English name of Sheep-eaters is a translation. They have been regarded as outcasts of the northern tribe and the contempt in which their more fortunate relatives held them would lend color to this conjecture.

They lived in perpetual terror of all men, both red and white, and took to the woods at the approach of a stranger near their lodges. It was this lack of communicativeness that made the Yellowstone unknown for such a long time, a fact in which we may rejoice for it was the salvation of the Park in a day when it would have been impossible for the Government to save it from spoliation. They were as dependent on the mountain sheep for food and clothing as the Plains tribes were on the buffalo. Their lack of horses made it necessary to travel light for which reason they did not use teepees but constructed brush lodges out of the material at hand.

Their distribution in the Park was determined largely by that of the mountain sheep. Col. Norris found a recently deserted encampment in the Lava Creek canyon and named the basalt wall above Sheep-eater Cliffs in consequence. Gen. Sheridan's party which entered the Park at Snake River found them in the vicinity of Mt. Hancock and Mt. Sheridan, but the five who accompanied the expedition had never seen the geyser regions. The shores of Yellowstone Lake seem

to have been a favorite summer camping ground where they could vary their diet with fish. The flat open country around Indian Pond ("Squaw Lake") was much frequented and the discovery of a number of obsidian implements and arrowheads during the construction of the Lake Shore road would indicate that the promontory between the Thumb and Lake proper was also used as a camp site.

There was no trace of any tribal organization in the group. After leaving the Park the Tukuarika lived for a time in central Idaho on the Salmon River. They were subsequently removed to the Lemhi reservation and later to the Fort Hall reservation with the related Shoshone and Bannocks. The Tukuarika were separately enumerated in the Indian Census as late as 1904 when they numbered 90 men, women and children. It is doubtful whether there were ever more than one or two hundred individuals in the entire two million acres of the Park.

* * * * * * * * * * * * * * * * * *

CHIEF JOSEPH AND THE NEZ PERCE WAR

By Charles Phillips
1890 - 1927

It was a strange twist of fate that the tribe of Indians who were to leave the deepest impress on the Yellowstone should be a remote one whose ancestral home was separated from the Park by the breadth of a modern state and that one of the wildest and least accessible. But fate has ever been the companion of the Indian since the day the white man set foot on his continent. More than any other people the history of the red man has been clouded by the shadow of a nemesis that hung over him and no tribe of the entire ill-fated race ever suffered more cruelly at its hands than the Nez Perces.

By one of the more playful quirks of this same fate the Nez Perces were ordained to bear a name that was wholly inapplicable. The term nez perce, "pierced nose", was given by the French-Canadian trappers indiscriminately to several tribes who wore nose rings and by chance became attached to a nation to whom the wearing of rings in the nose was unknown. There are other instances of names given to designate some tribal characteristic fastening themselves on a wholly innocent people. This was notably the case with the friends and allies of the Nez Perces, the so-called Flatheads, who never practiced the artificial deformation of their children's heads.

The Nez Perces had earlier and more appropriate names. Their own name for themselves was Tsutpeli which Lewis and Clark in the journal of their expedition corrupted to Chopunnish and by this name, with various spellings, they were known to early writers. Sahaptin, the title given them by the neighboring Salish ("Flatheads") was also used frequently in the early days. There has been some attempt recently to revive the latter name but the Bureau of American Ethnology has given oggicial sanction to Nez Perce.

The Salish term, however, has been retained in the name of the linguistic stock, the Shahaptian of which the Nez Perces were the most numerous and best known tribe. The Shahaptian group was more unified both in language and customs than most stocks; they occupied a compact area embracing those portions of western Idaho, southeastern Washington and northeastern Oregon that bordered on the Columbia and lower Snake River. Other tribes in this family were the Klickitat, Palouse, Tenino, Umatilla, Walla Walla and Yakima, several of which descriptions are preserved in the names of modern cities and towns in that region. The culture of the Shahaptian stock was that typical of the Plateau Area save only the Nez Perces; the eastern position of the latter and their frequent contact with the "buffalo indians" so modified their habits that their culture is intermediate between that of the Plains and of the Plateau and they are assigned to the first area by some writers and to the second by others.

The Nez Perces were a fairly numerous tribe as aboriginal stand rds went. It may be remarked here that the native population of the continent north of Mexico at the coming of the white man was far less than is popularly supposed, i. probably never much beyond a million. Lewis and Clark estimated the entire Nez Perce nation to be nearly 8000, altho this may have included several affiliated bands. The ancestral home of the tribe was the country between the Blue Mountains of Oregon and the Bitter-roots on the line between Idaho and Montana. In summer various bands roamed up and down the valleys of the Salmon and Clearwater Rivers but the approach of inclement weather brought most of them down to the Snake River where they wintered in the vicinity of the modern Lewiston. Many of the tribe made annual trips to the buffalo country in summer. Unlike the Bannocks who also visited the Plains to hunt, the Nez Perces were powerful enough to have no fear of the Blackfeet and took the most convenient route to the hunting ground whither they were bound. As most of these expeditions were made to the Judith Basin the most direct route took them north of the Park. In fact they were so unacquainted with the Yellowstone country that on their flight across the Park in 1877 they found it necessary to impress a white man in their service as guide.

Physically the Nez Perces presented a marked contrast to the typical Indians of the Plains. With the exception of the Comanches their stature averaged less than that of the Plains tribes altho at that they were of fair height. Their physiognomy also was noticeably different; among them the "hatchet-face" not infrequent on the plains was altogether absent and many individuals presented an unusual degree of broad-headedness. Like the Indians of the Plateau in general the Nez Perces were inclined to wear their hair long and unconfined, falling loosely over their back and shoulders. However, the influence of the Plains showed itself in the occasional wearing of the hair in two long, heavy braids.

The Nez Perces and their affiliated bands, notably the Cayuse, were the most proficient horsement of all the Plateau Indians. Indeed the latter tribe has given its name to a well known type of Indian pony that they first bred and was later introduced on the Plains. Their own traditions state that the use of the horse dates from the early nineteenth century; having learned of their value and their existence among the Indians far to the south they organized a strong war-party and captured a large number. With these as a breeding stock the use of horses spread rapidly to all the Shahaptian peoples.

The intermediate culture of the Nez Perces exhibited itself in their varied habitations. In the summer when hunting buffalo on the Plains or living the roving life of the Plains Indians within their own mountain valleys, they used the skin teepee. In winter they built a more permanent structure, a semi-underground lodge made by digging a hole several feet deep and erecting a wooden frame-work within it which was covered with the excavated earth, the whole presenting a mound-like appearance when finished. This form of dwelling was typical of the more sedentary tribes of the Plateau.

The diet of the Nez Perces showed a greater variety than that of the Plains people. In their own haunts their principal food was salmon which run in great numbers in the rivers of Idaho in the spawning season. Berries and roots, among the latter chiefly camas, were important staples. Those of the tribe who made hunting excursions to the Plains lived largely on buffalo meat after the manner of the Plains Indians. Large quantities of buffalo meat were brought back home with them either dried or in the form of pemmican as the aborigines had few methods of preserving flesh.

The political organization of the tribe was loose as this roving disposition prevented any tribal solidarity. Each of the numerous bands had several chiefs, one of whom was the acknowledged leader. These chiefs were often succeeded by their sons, a custom not general among the Indians. Thus Joseph's father was a chief among the Cayuse and while he himself was the leader of his band, his brother Ollicot as well as Looking Glass, White Bird, Big Thunder and others also held the rank of chief.

Lewis and Clark brought to the Nez Perces their first actual knowledge of the existence of white men, altho vague rumors to that effect had earlier reached the tribe from the east and south. This celebrated expedition entered the Nez Perce country in the autumn of 1805 under the guidance of the Flatheads who had brought the white men from their domain in the Bitter-root valley over the formidable range by that name by way of the Lolo Pass and down the Clearwater.

CHIEF JOSEPH AND THE NEZ PERCE WAR Phillips

The first band of Nez Perces was encountered near the present Weippe where they were gathering their winter supply of the camas that grows abundantly in that region. The usual exchange of presents followed and the explorers found the tribe among the most intelligent and friendly of all the Indians they had met. They spent two weeks here, building canoes, obtaining provisions and otherwise preparing for the last stage of their transcontinental journey. In their journal they comment frequently on the invaluable aid rendered by the Nez Perces in all these matters.

With the Flatheads the Nez Perces were the first Indians of the northwest to come in contact with Christianity. As early as 1820 these two tribes had come under the influence of Catholic employees of the Hudson's Bay Company and many were converted to that faith. In 1831 they delegated messengers to St. Louis asking that missionaries be sent them but the church was not able to comply with this request until 1839. In that year the Belgian Jesuit Peter J. de Smet, who later became well known as an explorer, founded a mission among the Flatheads in the Bitter-root valley which served as a nucleus for the entire field between the Rockies and the Cascades. In the meantime the Presbyterian mission had been established by Rev. Marcus Whitman in the Cayuse country in 1836. The latter tribe, however, resented the intrusion of the whites and a branch mission under Rev. H. H. Spalding at Lapwai among the Nez Perces fared better. The Lapwai mission had a small printing press, the first of its kind in the Pacific northwest. A worker at Kamiah, another branch mission, first reduced the Nez Perce language to grammatical form and the Indians soon had a considerable literature in their own tongue, largely of a churchly nature.

This long contact with the church developed in the Nez Perces an intensely religious nature. Altho most of them remained orthodox Catholics through the early efforts of the Hudson's Bay Company and the later influence of Father de Smet this in no way antagonized them toward the Presbyterian missionaries Whitman and Spalding. The work of the latter was chiefly of an educational nature and many prominent Nez Perces attended both the de Smet and Spalding mission schools. While it was no doubt the native strength of character of the tribe that made their conduct during the endless encroachments of the pioneers and especially in the war that eventually followed so exemplary, the ideals instilled by the high-minded and self-sacrificing mission workers deserve no small part of the credit.

An unfailing friendship and confidence in the white man had always been an outstanding trait of the Nez Perce character. It was they who interceded between the Government and the insurgent Yakima and their Shahaptian allies and made the treaty of 1855 possible. They themselves assented willingly to the terms of that treaty and ceded to the whites choice areas of their ancient hunting ground. As ever increasing numbers of emigrant trains filed into their territory they had ample opportunity to observe a type of white man far different in ideals from the workers of the missions. They noted among these pioneers a vast breach between the white man's conduct and his religion, a discrepancy incomprehensible to the Indian whose religion, pagan or christian, was his whole life.

Among the early proteges of the de Smet and Spalding missions none is more eminent than the Indian known to history as Chief Joseph. His native name was Hinmaton-yalatkit, translated as "Thunder-coming-from-the-water-up-on-the-land". Chief Joseph was a Nez Perce only on his mother's side, his father being a prominent man of the Cayuse tribe who had received the name of Joseph from Rev. Spalding of the Lapwai mission. "Joseph" seems to have been regarded as a family and was applied to both the chief himself and his brother Ollicot. Joseph's parentage is significant for the Cayuse were a more war-like people than the related Nez Perces and it is probable that Joseph acquired his military aptitude from his father which was tempered with the restraint inherited from his Nez Perce mother. Joseph himself was a man of remarkable physique and the dignity of his presence and his impressive bearing was acknowledged even by the bitterest of his enemies, both red and white. While he was eminent as a statesman and diplomat he has gone down in history as the greatest of Indian warriors, the only one who was able to out-general and defeat the United States Army again and again in the face of overwhelming odds.

CHIEF JOSEPH AND THE NEZ PERCE WAR Phillips

The Nez Perce War is typical of the conflicts that were frequent as the white man pushed his frontier farther and farther across the Great Plains. The undisputed sincerity, in this case, of the people and the standard of conduct of the chiefs put it on a higher plane than the others but the motive behind all was the same. The Indian was in every case fighting to protect the land that had been his from time immemorial and even though he stood in the way of "progress" and though his methods and ideals of war-fare were not our own, his attitude was merely his form of patriotism that among civilized nations is the most extolled of all virtues.

The white man, or rather the Anglo-Saxon, has been too prone to base his estimate of the Indians inherent worth on his material culture, an estimate which did him an unspeakable injustice for his material civilization never rose above that of the Stone Age while his spiritual and ethical development was quite the equal of that of the white invader and, in fact, often far superior to that of the whites with whom he came in contact. It may be remarked in passing that the French, a less practical and more sympathetic people, saw in the Indian a fellow human being and were thus able to enter the Indians point of view. By respecting his language and institutions and traditions they gained his confidence to a degree that was denied the more vigorous English and American pioneers. As has been said "They ruled while seeming to yield". Thomas Jefferson, of all American statesman, seems to have approached more nearly this ideal in dealing with the red man, a fact attributable to his interest and sympathy with French political and philosophical thought. The unvarying success of Lewis and Clark with the Indians may in all probability be traced to the influence of Jefferson under whose auspices the expedition was organized and with whom Lewis was for several years associated as private secretary.

An insuperable difficulty in dealing with the Indian was his theory of land tenure or rather, the lack of it. In the creation legends of many tribes human beings are literally the children of the earth, having been fashioned from clods or rocks, and their tribal ceremonies refer to the earth as "mother". Therefore it is not strange that the white man's conception of land ownership was utterly inconceivable to the Indian, especially to the roving non-agricultural tribes of the west. Land was like the air; it was something necessary to the life of the race and could not be appropriated by one individual to the exclusion of the others. Each tribe as a whole claimed a certain area as a hunting ground, the boundaries of which were well understood by their neighbors, and they did not usually abandon this claim except before superior physical force.

Again, the tribal organization was so loose that the tribe did not admit the right of one of its members, even an acknowledged chief, to act for all of them. On the Plains chieftanship was wholly on a basis of personal popularity and inheritance of leadership merely inferred an heritage of a father's esteem in the tribe. Equality and independence were the cardinal principles of the Indian's social organization. Tribal coherence was necessary for the mutual protection of its members but any individual or group was free to withdraw and live their life as they chose altho in so doing they relinquished all claim to protection from the tribe they had forsaken. This repudiation by some bands or individuals of the agreements and bargains made by the tribal leaders was a fruitful source of misunderstanding on the part of the whites who regarded such non-conformity as treachery or at the best, bad faith.

The Indian of the Plains is a hunter and when he fails as a farmer on a reservation it is unfair to judge him by his aptitude for an occupation for which he is fitted neither by temperament or heredity. Here we encounter the popular fallacy that the "bucks" are constitutionally lazy and that they enjoyed themselves hunting and making war while the women performed the labor. True, the time of the men was largely devoted to these two pursuits, but the existence of the community depended on their perseverance in hunting which by their primitive methods was extremely arduous and often fatal, while war ceased to be a recreation in a society that was never immune from the danger of attach in camp and ambush on the trail. The stremuous life of the Indian men for countless generations ingrained in them an unfitness for the drudgery of agriculture and it requires at least several generations to remold their character to a more sedentary life.

But to return to Chief Joseph's people. By the treaty of 1855 the Nez Perces had ceded to the United States a large part of their ancestral domain. The reservation as defined by that treaty lay largely in Idaho but also included the valley of the Wallowa River on the east side of the Blue Mountains in Oregon. The tireless efforts of the prospectors in this region was rewarded finally by the discovery of gold near Pierce City in 1860. Shortly the reservation swarmed with hordes of miners to whom government regulations and particularly Indian treaties were matters of small moment. The resentment of the Indians and the lawlessness of the miners threatened serious consequences and the local Indian agent arranged a temporary agreement between the intruders and his wards until the government should have time to take official action. By this agreement the whites were to have mining rights in certain designated portions of the reservation.

The newcomers were strongly of the opinion that good mining country was no place for Indians and entrenched their position by building the city of Lewiston on a site within the reservation to which they had even no temporary right. They improved the occasion further while the Government was taking action by other projects that were to serve the original inhabitants that they were there to stay. This situation continued for several years and finally sufficient pressure had been brought to bear upon the Government to secure a new treaty.

By the treaty of 1863 the Nez Perces were deprived of a large portion of the earlier reservation including the valley of the Wallowa, the Alpowna valley and the Salmon River country. This treaty was signed by only a part of the tribe, principally by those bands who were not affected by the revised boundaries. Joseph, chief of the Wallowa band, and other men of prominence, rejected the new document flatly, and the "Non-Treaty Nez Perces" continued to occupy the territory allotted them by the treaty of 1855 in spite of the collisions between the whites and themselves that became more and more ominous. For thirteen years the Government endeavored to reach some satisfactory adjustment but any settlement that was fair to the Indians was deemed impractical by the settlers. In the meantime several influences were at work among the Nez Perces that were gradually undermining the former confidence of the tribe in their white brothers' civilization.

Most potent of these was the cult of Smohalla, the "Dreamer". It was natural that the story of Christ, the Savior, should make a profound impression on the deeply religious nature of the red man and when he became overwhelmed with the inevitableness of his own destiny, the labor of the pious missionaries bore unexpected fruit in the various Messianic movements that, appearing at first sporadically here and there on the plains, finally culminated in 1888 in the Ghost Dance. The teaching of Smohalla, the Messiah of the Nez Perces, gave a supernatural and even divine significance to convictions that had been growing in intensity for a long time and in the late 60's and early 70's the prophet numbered his adherents in the tribe by the thousands, Chief Joseph himself and his band being among the most devoted of his disciples.

The message of the "Dreamer" was, briefly, that the Indians must return to their primitive mode of life, renounce the teachings of the white man and be governed in all things by the will of the Indian God as revealed by the dreams of Smohalla and his priests. This self styled Christ of the red man taught that "the Creative Power when he made the earth, made no marks, no line of separation or division upon it and that it should be allowed to remain as it is" and further that "it should not be disturbed by man and that there should be no cultivation of the soil or other improvements or any voluntary submission to the control of government." It is obvious that this is merely the Indian version of the most extreme form of modern radicalism and that it is rooted in the same soil, the exploitation of the economically weak by the strong.

The political events of these two decades had likewise wrought a profound change in the Indians attitude. The Civil War had shaken his faith in the Great White Father's Government and he was particularly impressed by the lack of unanimity between his white brothers. The bitterness of the war and of the reconstruction period marred the ideal of fraternal love that the

missionaries had preached and had themselves practiced.

Then, too, the white man did not appear as invinceable in arms as he had when the Indian possessed only the bow and arrow, or at best, antiquated fire-arms. The victory of Red Cloud who forced the soldiers to a capitulation at Fort Kearny in 1868 and a complete withdrawal of the military from northern Wyoming, re-established the confidence of the Indian in his ability to avenge himself by force of arms. Minor successes for several years kept alive this hope. Then in 1876 again, the complete annihilation of Custer's troops filled him with a sense of exultation and assurance that the God of the Indian would sustain him.

As before remarked, thirteen years elapsed before the Government took further action regarding the fate of the Nez Perces. In 1876 a joint civil and military commission was appointed to visit the reservation and make an investigation of the situation. The commission seems to have been chiefly impressed by the"pernicious"teaching of the "Dreamer" and concluding that the treaty was the most practical solution of the controversy, recommended putting the Indians, the non-treaty bands as well as the signers, back on the new reservation at Lapwai using military force if necessary. This in [illegible] itself would be construed as an act of war among civilized nations for the "Non-Treaties" had never signed or recognized the validity of the document.

Even though the Indians had by this time discarded the white man's dress that they had worn for many years and were attending the conferences in their ancient war costumes and bedecked in red paint, yet they were inclined to be reasonable and the negotiations were proceeding to a peaceful settlement when new outrages on the part of the settlers in the spring of 1877 broke down the barriers that had hitherto restrained the pent-up emotions of the tribe, emotions that were being lashed to a frenzy by the speeches and dances of the "Dreamer" prophets in their mountain retreats. Twenty whites were killed, the perpetrators of the deed being for the most part young bucks acting without the sanction of Joseph. The latter was aware that the Americam public would be in no mood after the Custer Massacre to consider conciliatory measures and since the die had been cast, he urged the tribe to take united action to avoid the utter annihilation that would be demanded by the whites.

A state of war was declared on June 13th and Gen. Howard who had been recalled from his headquarters at Portland to put the Indians on the reservation, took charge of the situation. For a month the Indians remained in their ancestral valleys, meeting the soldiers in three engagements in which they gave evidence of a military ability that demonstrated to the authorities they had aroused antagonists that would require the bending of every effort to master. Accordingly additional troops were summoned from more distant posts.

On July 11th the Indians fought a severe engagement on the Clearwater in which they lost heavily but gave a good account of themselves. Joseph was by this time convinced that his only hope lay in reaching Canada and the following day the tribe left their home for the Plains. Their route took them over the Bitter-root Mountains by way of the now famous Lolo Trail over which they had so often crossed to the buffalo country and by which Lewis and Clark had come to them seventy-two years before. Once over Lolo Pass they were in the country of their friends, the Flatheads, who rendered them much assistance without actually joining in the hostilities. Their old trail had turned north here, past Fort Missoula and across the Rockies near Helena. This, however, would take them through dangerous territory so they swung to the south, passing up the Bitter-root valley to its head and crossing the Continental Divide by the pass now known as Gibbon's Pass. The Bitter-root valley was thickly populated with whites even at that early date but the Indians refrained from all lawlessness and purchased all the necessary supplies of food and ammunition.

Incommoded as they were with women and children and all their household effects, rapid movement was impossible, a fact of which the military took full advantage. It was early August before they left the Bitter-root valley and August 9th found them in camp on the Big Hole River in southwestern Montana. Here they were attacked by Gen. Gibbon with troops from Fort Missoula and other Montana posts. Gibbon had waited for them at Missoula at the north end of the valley and finding they had eluded him, started in pursuit. The battle of the Big Hole (Aug. 9-10-11) was a complete victory for the Indians but at a heavy loss.

It enabled them, however, to continue their retreat and the next day they crossed the Bitter-roots again, back into Idaho by way of the Bannock Pass. In this wild country they had a few days of comparative rest during which time they moved along the south flank of the Divide in the direction of Henry Lake.

On the night of August 19th the whites made an attack on their camp at Camas Creek thirty miles southeast of the lake, firing into the tents and killing many sleeping women and children. Joseph's generalship again enabled him to extricate himself from his dangerous position and cover his withdrawal to Henry Lake, about fifteen miles west of the West Entrance of the Park. This lake ha had a stirring history in the first part of the century when the well-known trader Andrew Henry built a post at the outlet in 1810 and in the 70's was still a favorite rendezvous of the surrounding tribes.

When Howard arrived at the lake on the morning of August 23rd with his exhausted troops the Indians had left but a few hours before. He was forced to remain here for several days to let his men recuperate; meanwhile Joseph and his band had crossed the Continental Divide over Targhee Pass and were well within the Park. Avoiding the Bannock Trail they pushed up the Madison and thence up the Firehole, going into camp that night near the north end of the Lower Basin. During the day they had encountered a white man by the name of Shively. While there is no record of Shively having been threatened with his life he was evidently of a mind that discretion was the better part of valor and entered their service as guide.

The Indians were on the move at daybreak the following morning and a few minutes later the advance party sighted an encampment of tourists at the foot of the ridge between Fountain Geyser and the Firehole. The group included seven men and two women, all from Radersburg, Montana, under the leadership of Geo. F. Cowan. The camp was soon filled with a band of younger warriors who were in the van of the main body of Nez Perces. They were evidently bent on mischief, but the arrival of Looking Glass and shortly after of Joseph himself, put an end to their designs. Cowan addressed his demands for immediate release to both Looking Glass and Joseph but neither replied. The Indian who had acted as interpreter then told them they were to be taken along with the Nez Perces. Being in no condition to resist, they complied, and the party moved up Nez Perce Creek. A few miles above the present bridge the trail proved impractical for the wagons which were abandoned. The march continued until the noon stop which was made at the foot of Mary Mt. While the squaws were preparing food the chiefs held council and it was decided to confiscate the whites equipment and horses, leaving them sufficient supplies and broken down Indian horses to return home.

The Indians continued their journey and the tourists started on the back trail when presently a large party of young bucks galloped back. Ascertaining that the chiefs were far enough in advance not to interfere with their sport the young bloods commenced to harass their victims and finally began shooting. Cowan, whose conduct in the camp that morning they had resented, received three bullet wounds and was left for dead and the rest of the men escaped. The two women were taken prisoner but were released at the next camp without injury. The varied experiences of the party after the attack and especially of Cowan are doubtless the most remarkable, with the possible exception of that of Everts in 1870, in the history of the Park and form a fascinating chapter in Chittenden's volume on the Yellowstone.

In the meantime the main body of Nez Perces had climbed Mary Mt. and descending the more gentle eastern slope, swung out into Hayden Valley. Skirting the ridge to the south they encountered the head of Elk Antler Creek which they followed to its junction with the Yellowstone River. Their objective was the ford near the Mud Volcano, the only practical crossing of the river between the canyon and lake. Here the Indians encamped for two days and in the interval a party of the younger men, probably the same band who had attacked the Cowan party , indulged in a second of those escapades which form the only discreditable episodes of the whole Nez Perce campaign. Both of these outrages were committed by the more lawless element of the tribe without the sanction or even the knowledge of Joseph for in each case the rowdies participating took no small pains to conceal their activities from the chiefs whose indignation they had reason to stand in awe of.

A party of tourists from Helena had encamped near the Lower Falls on the evening of August 24th and the following morning resumed their journey up the river. Near the Northern Pacific Trade-Mark they sighted Indians in the distance at the ford. Beating a retreat they pitched camp back in the timber on Otter Creek, a small stream that enters the river about a mile above the present bridge. The second morning following two of the party went up the river as far as Sulphur Mountain (Crater Hills) to reconnoitre and found no trace of the hostiles. On their return they met a band of Indians near Alum Creek. Making good their escape in the face of a brisk fire they reached the Otter Creek camp to find that the same band had already attacked it and driven their companions to cover. One man had been killed and several wounded. The scattered survivors after many hardships finally reached shelter, two with the pursuing troops on the Madison River and the others at Mammoth.

Weikert, one of the party who reached Mammoth, set out August 31st with C. J. McCartney for Otter Creek to find out what had become of the others. McCartney was the proprietor of a small log "hotel" that stood until recently on the low knoll at the mouth of Chinaman Gulch. It was used as the Park Superintendents office in the early military days and still later by a chinaman who operated a laundry there and incidentally gave Clematis Gulch its better known name. During their absence a party of renegades who had left the main body when Joseph broke camp at the Mud Volcano, came through Mammoth and went down the Gardiner River to a point several miles outside the Park. On their return the Indians found several of the Helena survivors at McCartney's Hotel. One, Dietrich, was shot and killed in the doorway. The colored cook fled up the gulch with the savages at his heels, but by dint of strenuous tree climbing and ardent praying, got away with his scalp intact. Near Undine Falls the Indians encountered Weikert and McCartney on their way back, who also escaped after a brisk chase up the side of Mt. Everts. As before remarked these outrages form the only regrettable conduct on the part of the Nez Perces and even they might be defended on the ground of reprisals for, as Chittenden says, "the Indians might justly reply that the whites had fired into their tents where their women and children were sleeping."

On August 26th Joseph and his people were again on the move. They crossed the Yellowstone River and ascended it along the east bank to the outlet, where they turned to the east and followed the lake shore to the mouth of Pelican Creek. Their route up the Pelican valley was essentially that of the present trail, over the Minor Plateau and down Mist Creek to the Lamar Valley. Instead of travelling the logical route down the Lamar and up Soda Butte Creek they turned at the mouth of Miller Creek to avoid Cooke City where they feared armed resistance, and followed that stream to its head, crossing the Absarokas over the pass between Indian Peak and Hoodoo Peak just north of Hoodoo Basin. They left the Park September 5th in anticipation of which Gen. Sturgis with some troops from the eastern posts had been directed to intercept the Indians as they came out of the Absarokas. The latter, however, learned of his plans and emerged by a pass that he had left unguarded, thinking it was impassable.

The Indians moved down the Clark's Fork rapidly as Howard was by this time close behind and a week later they were at the Yellowstone River again. They crossed the river September 12th near Laurel and the following day an encounter took place about a dozen miles west of Billings with Sturgis' troops, who had been in hot pursuit since he was foiled in the Absarokas. The whites were too few in number to do much damage and Joseph withdrew in a northerly direction along the west flank of the Bull Mts. until he reached the Musselshell River. The Nez Perces were now approaching their old buffalo hunting ground and the country was thoroughly familiar to them. They moved up the Musselshell for a short distance and then swung north for Judith Gap. This historic gateway, guarded by the Big Snowy Mountains on the east and the Little Belt Mountains on the west had been a passage way between the Yellowstone and Missouri Rivers from time immemorial, and Judith Basin, just north of the Gap, was famous among the Plains Indians as a buffalo country. The Nez Perces hugged the west slope of the Big Snowies, passing over the site of the modern Lewiston.

In the meantime troops were being concentrated on the Missouri near the mouth of the Musselshell from Fort Buford on the Montana-Dakota line and Fort Keogh near the present Miles City with General Miles, at that time Colonel Miles, of the fifth infantry of Fort Keogh, in command. It was obvious that the Indians were making for Canada and the only hope of the troops lay in cutting them off from the boundary.

Joseph crossed the Missouri at Cow Island on September 23rd. Movement was slow for he was in difficult straits, his men and horses exhausted and his food supplies nearly gone. Still struggling northward they made their way through the Bear Paw Mts. and here on Snake Creek in the first days of October Joseph found himself surrounded, Howard behind him, sturgis on his flank and Miles with fresh troops between him and Canada. Within thirty miles of freedom the Indians fought with grim desperation but were not able to cut their way out. The three officers whose admi ation Joseph had won by his conduct and his leadership were loath to annihilate the little band of survivors and Gen. Miles under a flag of truce arranged a conference. He urged Joseph to surrender and the old chief who had lost heart at the death of so many of his band, including Looking Glass and his brother Ollicot, finally agreed on the stipulation that he and his people be allowed to return to Idaho. This Miles promised in all sincerity and October 5th the Indians, except a number who had escaped into Canada, gave themselves into custody.

But Joseph had yet to drink the last drop from his cup of bitterness. Gen. Miles had treated with Joseph as one soldier with another but the Government, ignoring the Generals promise, visited upon the Indians all the ignominy of criminals and sent them virtually as prisoners to Fort Leavenworth. Later they were moved to Indian Territory still under Government surveillance. The environment here, however, was so inimical to these mountain people that many died from disease and in 1855 the Government relented sufficiently to send part of them back to Idaho. This final privilege was denied Joseph and his own band who were removed to the Colville reservation in Washington.

Here the old warrior lived for nearly twenty years; long enough to visit Pres. Roosevelt and Gen. Miles at the capital; long enough to become reconciled to civilization and to lend his aid in the education of his people; long enough to see the American public change in its attitude from regarding him as an object of vituperation to a true appreciation of his character. And here he died September 21, 1904, universally acknowledged the most remarkable character the red race has produced in North America.

Since the Indian refused to be assimilated his annihilation was inevitable. A weaker race stood in the path of expansiom of a stronger who with all its short-comings had infinitely more to contribute to civilization. Now that his scalping days are safely past that mixture of fear and contempt with which the Indian was formerly regarded is giving way to an unprejudiced interest in his mythology, art and music. It is unfortunate, however, that the white man was so out of sympathy with his red brother when the latter was in his prime for his spiritual out-look, uncouth as it may appear to our eyes, might have done much to leaven the materialism that threatens to be the downfall of the civilization of the paler race.

THE GENESIS OF YELLOWSTONE NATIONAL PARK

By Frank Thone, Ph. D.

A lecture by Dr. Frank Thone as delivered at Mammoth Hot Springs season of 192?

Opening paragraph omitted; must be varied according to season and other circumstances.

Come back with me for a moment to a time when the earth was young. There was in those days no Yellowstone National Park - no North American continent even. Far to the east where the Appalachian Mountains now are rose a high mountainous island mass. To the west there rose a similar mountainous island mass and in between the two lay a vast shallow inland sea. The animals that lived in that sea left their shells and skeletons on the bottom when they died and these in the course of the ages accumulated and hardened into vast beds of limestone. The rivers that flowed through the mountainous islands carried down with them great quantities of sand and silt which in the course of the ages accumulated and hardened into beds of sandstone, shale and slate. How long this process was continued we do not know, but it must have occupied a very long period of time for the total accumulations have reached a vast thickness. In the end, however, the sea bottom slowly heaved itself above the surface of the water and became permanently land.

In the meantime the mountains to the west had become much worn down, and in the west new mountain ranges rose to take the place of the old, forming what is now known as the Rocky Mountain System. The main ridge of the new mountain system, as we all know, ran in a north and south direction, but in places short cross ridges were also folded up, forming great mountain bowls. The area now known as Yellowstone National Park occupies a part of what was once such a mountain bowl.

Now where we have intense mountain folding such as I have described, we are likely to have developed what geologists call lines of weakness in the surface of the earth - thin places where volcanic forces may become active. Volcanic activities on a vast scale took place took place in this mountain bowl. Within the bowl there were at least three enormous volcanoes, probably larger than any that now exist, and around its edges were a large number of smaller volcanic vents and craters. Naturally the quantity of lava produced was prodigious. There were many volcanic eruptions and flows, which slowly filled up the bowl and it even overflowed thru the low places in its rim, helping in the formation of the vast lava plains outside, notably to the west and south.

In time, however, the main phase of volcanic activities came to an end and the lavas flowed no more. There followed a second and explosive phase of volcanic activity. Chunks of rock up to three feet in diameter and great volumes of finer material were blown from the craters by steam, and mantled thru the adjacent forested country. The tops of the dead trees projecting above these pyro-clastic (clastic - broken, pyro - by fire) deposits naturally rotted off, but the stumps, partly protected beneath the surface, decayed very slowly indeed. They fell to pieces atom by atom, and as they did so the wood was replaced atom by atom with silica, a hard strong substance in solution with the water. So accurately did this silica replace even the most minute detail of the wood that we can now tell accurately what species of trees constitute the great petrified forests found in this place.

Curiously enough they are not such trees as are now found in this part of the world, but belong to genera represented in somewhat warmer climates than this. There were such trees here as we now find at low elevations, in California and the Gulf States: the big redwoods, sweet gum, live-oaks, magnolias and many others. There were many of these hot mud flows and many forests were thus overwhelmed and [illegible]petrified. At Specimen Ridge in the northeast part of the Park there are at least 12 layers of petrified tree stumps, the roots of each layer above the tops of the preceding ones, thus indicating a succession of at least 12 of these showers of volcanic dust and bombs.

In time the explosions also ceased and the volcanoes at last were completely extinct. There followed, however, a third and final phase of volcanic activity - the development of geysers and hot springs. A geyser is not a primary

volcanic phenomenon, that is its waters do not come from deep within the bowels of the earth as did the lava and the hot mud. They are instead simply surface waters that have trickled down from fissures and cracks in the earth and have been heated by volcanic steam and gases rising from still uncooled masses of lava far below. For the formation of a geyser, or hot spring, three things are necessary. First, a supply of heat. This comes, as I have already indicated, from steam released from the cooling masses of buried lava that have been so thickly blanketed that they are still hot, tho ages may have elapsed since they were first forced into their present position. The second conditio is a tube or vent, thru which the eruption can take place. This may be simply a crack in the earth or it may be a tube that the geyser has formed for it self out of silica. The third condition is, of course, a supply of water. This comes from the surface from melted snow or rain. The water trickles into the tube either thru the top or thru underground channels opening into the sides of the tube, fills it up, becomes heated and super-heated by the steam rising from the hot lavas below and finally blows up in a violent eruption.

It may be worth while to note in passing the reason why geysers have not been developed here at Mammoth as they have been at the other places in the Park. The formation here at Mammoth consists entirely of limestone - soft, chalky and very weak. Accumulations of energy sufficient to cause geyser eruptions would very quickly rip the formation here to pieces. The formation elsewhe-in the Park consists of silica which is much harder and stronger than limestone and is thus able to form tubes which can withstand the explosive pressure that accompanies geyser eruptions. Hence we have here at this place the constant slow bubbling whereas in the geyser basins we have the accumulations of energy and the final violent blow-off.

Now after the geysers and hot springs had been in action for some time there came over the earth that peculiar change of climate that brought about the glacial epoch, or great ice age. The ice in this part of America was not connected with the great continental ice sheets that formed in the northeastern part of the United States and over most of northern Europe. They were in-stead huge mountain glaciers of ordinary type. These slowly pushed their way across the Park plateau and down the valleys, gouging out great masses of rock which they ground down to boulders and crushed to powder. Then the ice age cam to an end and the glaciers melted and retreated, these loads of boulders and silt were dumped in the ice-cut valleys forming the rounded hills or moraines which we can see all about us here in the canyon of the Gardiner. We know that the glaciers came after the geysers and hot springs had been formed because at the top of Terrace Mountain, directly above us here, there is a deposit of glacial boulders on top of the hot springs limestone formation.

After the glaciers had disappeared the climate continued to grow milder and there was a return of the vegetation which had been banished during the glacial epoch. The trees that came in, however, were not the trees that had departed. They are a sterner, hardier race, fit to cope with the more severe climate that has been left us as a heritage of the ice age. The trees that form the bulk of the forests that cover the larger part of the Park are lodgepole pines. The lodgepole pine is the dominant tree on the Park plateau, the tall, slender, rather weedy tree that grows in such dense and crowded stands almost everywhere. Below the lodgepole pine level we have the limber pine, so called because its twigs can be tied into knots without breaking. This is the common pine in the neighborhood of Mammoth. Above the lodgepole pine level is the whitebark or whitestem pine. This is a close relative of the limber pine, but grows only on the high mountain elevations. Considerable growths of this tree occupy the flanks of Mt. Washburn. In addition to the pine we have considerable quantities of Engelmann spruce, balsam fir, and Douglas spruce. These three species usually occupy the richer, moister valleys and ravines. In the drier woodlands of the Park we have considerable quantities of that peculiar juniper which is usually called Red Cedar. Of the broad leaved trees there are very few and those that we have are mostly two species of poplar: the little white barked quaking asp, or aspen, very common at lower elevations, and the narrow-leaved cottonwood, which is found in the valleys of the Gardiner and the Lamar Rivers. Other genera that reach tree size at lower elevations, like maple, willow, birch, cherry, etc. are here nothing but tall shrubs. The open dry plains and hillsides of the Park are occupied with a brush formation domi-nated by sage brush with a liberal admixture of rabbit brush and other drought-resisting bushes. There is also, of course, a great wealth of floral plants. Altogether about 600 species of flowering plants have been identified in the Park

Sheltered by the forests and supported, directly or indirectly, by the plant life is a great wealth of animal and bird life. The largest and most numerous of the larger mammals of the park is, of course, the elk. Recent estimates place the number of elk in Yellowstone Park at about 20,000. Much less numerous, tho still present in considerable abundance are the mule deer, and there are still a very few of the white-tailed deer in the region. The park shelters a herd of about five hundred of the rapidly disappearing pronghorns or American antelopes and a considerable number of magnificent bighorns or Rocky Mountain sheep. On the borders of the park we occasionally get glimpses of the Yellowstone moose, a very peculiar animal quite distinct from the huge northern moose of Maine and the Canadian woods. Of course the great pride of the park is the herd of American buffaloes, or bison, which started a little less than 30 years ago with about 25 animals and has increased its number under the careful protection and feeding they receive here until the herd now numbers more than 800 specimens. Beasts of prey are the only things that are ever shot at or otherwise killed in the park, particularly the grey wolves and the American lion or mountain lion. There are considerable numbers of coyotes in the park and their number is kept within bounds by shooting and trapping, but they have not been so greatly reduced in numbers as have the other two groups of predatory animals.

Most interesting of all of the larger animals in the park to the average visitor is the bear. We do not frequently get to see the grizzly, for he is of a very shy and retiring disposition in spite of his ferocious reputation and avoids contact with human beings wherever that is possible. We may occasionally get a glimpse of him at the bear feeding grounds when he comes out at dusk to get his share of the food scraps that are thrown away. Much more pleasant and much more easy of approach are the black bears, for the brown and cinnamon bears are cimply color phases of the common American or black bear, just as we have blondes, brunettes, and red-heads among people. Bears should always be treated kindly but with caution. The frequent practice of letting them eat out of your hand while a friend takes a photograph is absolutely dangerous and is a thing that no experienced ranger or other park official or employee ever undertakes. Bears as a rule are not vicious, but it is to be remembered that they are exceedingly stupid and just as strong as they are stupid, so that a mere gesture of impatience on their part may be a disabling or even deadly blow if a human being happens to be in the way of it. We, therefore, very strongly urge that you toss your offering of food upon the ground at a safe distance, say 12 feet at least, which will place the bear in a good photographing position and at the same time insure your own safety.

In addition to the furred animals of the park there are a great number of birds. The park, indeed, is one of the greatest natural bird sanctuaries in the world. All told, about 300 species of song birds and water-fowl visit us in the summer and some of them are here all of the year. The American or bald eagle is a permanent resident in the high mountains around the border of the park. We seldom see him near the roads except on the wing occasionally. A bird which is frequently taken for the eagle, and whose nest is sometimes pointed out as an eagle's nest, is the osprey or fish-hawk. The osprey is much less shy of human approach and builds his home freely on lofty pinnacles of rock or in the tops of tall dead trees. Smaller hawks are here in abundance and also a great number of owls. Along the stream courses one will frequently find great numbers of ducks and geese and wading birds, and at Yellowstone Lake are two of the most interesting water bird colonies to be found in the United States. There are about 200 pelicans and an indeterminate number of gulls at this place. These birds come up every spring from the warm waters of southern California where they spend the winter. Of smaller birds there is a great wealth. Perhaps the bird most frequently noted is the western bluebird which is blue all over - a bird to delight the heart of Maeterlinck. Another interesting small bird which stays here all year round is the water-ousel. Altho a water bird the ousel does not have webbed feet like a duck nor long legs like a snipe. He is a literal submarine bird which can walk on the bottom of rushing streams, clinging with his strong toes to the stones at the bottom. He builds his nest as a rule under a rock in the middle of a rushing rapid or beneath a waterfall.

Author's note: These notes on the plant, animal and bird life of the park may be varied to suit the occasion and to fit the time at the lecturer's disposal. As originally given the treatment of the birds was placed before that of the animals so that the lecturer could wind up effectively with a discussion of the bears. At the close the audience was solicited for questions.

NATURAL HISTORY OF YELLOWSTONE NATIONAL PARK

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

"In the great earth drama whose theme was the making of a continent, some of the most stirring scenes were laid within the bounds of our National Park on the Yellowstone. Rocks of all the ages may be found there, and in them is written its story for those who understand to read.

"Its history as a permanent land surface, so the record runs, begins with the great orographic movement by which almost the entire Rocky Mountain system was outlined - by which the vast reefs and sandbeds of ancient seas, and the rubble ofnameless shores were crushed together, folded and faulted, and lifted thousands of feet above the sea; so that the ocean floor of ages past wrinkled to become the mountain top of today.

"Following the mighty labor of upheaving mountain ranges there seems to have been a period of rest - rest upon the surface only, for beneath it a fiery brew of molten rock was gathering.

"'Active volcanoes surrounded the Park on the east, west and north, and broke out in the central region'". (Yellowstone Park Folio, U. S. Topographic Survey). Visitors entering the Park from the north are introduced at once to Electric Peak, an imposing mountain mass, snow-streaked in mid-summer, that stands like a sentinel on guard at the northern boundary of the Park. During the period just referred to Electric Peak was an active volcano, pouring its floods of liquid rock over the region so beautiful now. The extensive lavas that cover the greater part of the Park give evidence how prolonged was the pouring of these scorching libations. The whole range of the Absarokas, which cradle the waters of the Yellowstone, was built up by successive lava flows; and a thousand feet of basalt covers much of the Park to the north.

"The surface of these older volcanic flood plains is deeply eroded, showing that for a period of time impossible to measure, the great volcanoes lay dormant, while external agencies, wind and rain, the sun of summer and the frost of winter, exerted their energies. Then the flood-gates of the mountains were again opened, and vast quantities of that variety of lava called rhyolite flowed over the old, eroded surface. Mount Washburn was now the most active center, with Mount Sheridan, whose picturesque outlines add so much to the scenery of Yellowstone Lake, but little inferior in energy.

"No man saw these vast outpourings; for the time of man's coming was yet untold ages in the future. The whole period of the great Ice Age lay between that time and his. But they ceased at last. Earth, weary of her groanings, fell asleep for a season. Never again did the great volcanoes pour out their fiery flood. But their furnaces are not even yet cold; for the hot springs and geysers of today, scattered by thousands over the Park, are but the expression of their dying energy.

"The end of this act in the great Park drama found it approaching its present form - that of a volcanic plateau in the heart of the Rockies, more than 8000 feet above the sea in its higher parts, with peaks and ridges that rise from 2,000 to 4,000 feet higher still.

"Just when the dying volcanoes ceased to pour out molten rock, just when they began to substitute boiling springs and eruptive geysers for flowing lava, it is impossible to say. It is known, however, that springs and geysers had been long in action when the pendulum swing of change brought bitter cold, and vast fields of moving ice covered the land where liquid rock once flowed. In the Teton range today, small glaciers still move down the mountain slopes. They are the last survivors of that battle royal of the snow jekuls of the North, when, in the long winter of the Ice Age, the Park was the center of glacial movement.

The ice mass waxed and waned with growing cold and returning heat. And as the floods from its melting subsided, the curtain rose upon the last act in the drama of the Park - the Age of Man. Yellowstone Lake fell to its present

level, leaving its record 160 feet above, in the water-worn gravel that covers the old lake terraces. Rivers shrank in volume, carving their way down through the solid rock, cutting wild canons as they flowed over the deep descending slope. The boiling water of innumerable springs soaked into the old volcanic rocks, altering their composition by chemical action; changing the very texture of the stern gray rock, making it susceptible of sculpture into wierd towers and pinnacles where eagles love to build their nests; and by slow alteration into new compounds, painting the rock walls with the exquisite coloring that is the final fascination of the Grand Canyon of the Yellowstone. The vegetation of today gained a foothold; wild animals of many kinds found a home there; and the Park assumed its present aspect."

-- M. E. Andrews: Yellowstone Park.

* * * * * * * * * * * * * * *

THE GEOLOGICAL HISTORY OF YELLOWSTONE NATIONAL PARK

By Ranger Gerrit Demmink

Approved by: Superintendent Horace M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

I suppose that many of you have been suspicious of my subject from the moment it was announced. The first mention of geology as something of interest here in the park might make some people run for shelter. One is curious, of course, about the things around here, and naturally seeks explanations; but perhaps, at one time or another having read a technical pamphlet or dipped into a book on geology; or having probably talked to some scientific men, has become too impressed by the complexity of the subject and perhaps discouraged as well. Well, I am not going to lecture on geology in a technical way at all. I am not going to bother you with complex scientific terms which have no particular meaning for the person who has not made special study of advanced geology. And along this line I like to relate an incident which took place in Yellowstone a number of years ago. Battling Nelson, the prizefighter, once spent a summer here training for one of his important fights. At the end of the summer he thought he might commercialize on his experience somewhat and get out a booklet entitled: "My Experiences in Yellowstone". When this work was finished, he noticed that something was lacking. He felt that he should have a brief geological treatise to go along with the book. Now Battling Nelson's ideas on geology were elementary, to say the least, and so he arranged for an interview with Arnold Hague, an eminent geologist who was studying Yellowstone at that time. Arnold Hague saw the chance for some fun at Battling Nelson's expense, and so he evaded most of the questions put to him by the prizefighter, pleading ignorance of them and showing a surprising lack of understanding of all that Nelson was talking about. And finally Battling Nelson became impatient and exclaimed, "Well now, Mr. Hague, to get down to something simple and definite, what, for example, is that mountain over there ?" "Oh", said Arnold Hague, "Why that's an andesitic porphery with radical spherulitic inclusions." Battling Nelson later said that that was the nearest he ever came to being knocked out.

I am not comparing you to an audience of Battling Nelsons; but I shall endeavor to explain the more prominent features of the park in everyday language which I hope will be interesting to you. Necessarily, I must do this in a very sweeping general way, - the idea of covering the geological history of the park in thirty minutes is inconceivable. But I can suggest broad outlines upon which you may base your observations as you travel thru Yellowstone.

I am going to follow the method of the geologist who goes "deep" into his science, and talk to you of an orderly succession of geological layers, which reveal the processes and stages thru which this part of the earth's crust has passed.

The first layer with which we are concerned is that of the sedimentary rocks, - the old sea bottom. At one time all of this district must have been covered with a shallow sea. We know this because fossils of fishes and other sea

animals have been found in this layer. The limestone stratum also shows that it is of sedimentary origin. Mud and silt carried down by rivers, together with the vegetable and animal deposits, formed a layer of considerable thickness on the sea bottom. Later, as the waters receded, this sedimentary layer was revealed as land in the ordinary sense of the word. There is a large deposit of sedimentary rock in Mt. Everts which may be seen from the hotel. These sedimentary deposits are of real interest when we come to consider the hot springs, and I want you to keep them in mind. It suffices to say here that they constitute one of the lower layers upon which other geological layers have been built.

On top of the sedimentary rocks we find the igneous rocks, - the lava flows. Most of the present topography of the park has been mounded by volcanic action. You will see evidences of it everywhere as you go along. The central portion of the park is a broad plateau, formed by lava flows, filling up what was formerly a great valley. Many of our mountains here are great banks of lava which have piled up above the general level, and it is most interesting to observe the crystalline forms of the rocks exposed by erosion, as well as the variety of their composition.

As you pass thru Golden Gate there is an opportunity for close-up observation of this igneous rock structure. Obsidian Cliff is essentially a mountain of volcanic glass, - a lava which cooled so quickly or was so viscous that it did not crystallize. Again, just beyond Tower Fall, you will be curious about a long layer of upright, pentagonal columns. Most people are surprised at the evenness and regularity of these rock columns. Under favorable conditions, lava masses in cooling tend to assume certain geometric forms related to the principal constituents of the lava. These five sided columns are remarkably symmetrical. And so, in going around the park, one observes immeasureable masses of igneous rock.

After the igneous rock we have the glacial deposits. I said that most of the present topography of the park was due to lava flows. In many places it has since been modified by glacial action. Here and there the glaciers wore down the knobs and higher places, and gouged out the valleys more deeply. Then, too, there are the glacial deposits, - great banks and mounds of gravel piled up by the ice movement, and also huge boulders which were left along the path of the glacier. Capitol Hill, directly in front of the hotel, is a good example of a glacial terminal moraine. The gravel hills between Mammoth and Gardiner have been deposited by glaciers. At Canyon you will see the glacial boulder, a huge rock which rests on an andesitic lava flow. The only plausible explanation is that it was carried by a glacier, and it must have been transported several miles, because the nearest source of granite, of which it is composed, is some twenty miles off, - a rather interesting evidence of glacial activity.

Finally we come to the thermal deposits, and that, after all, is what you are probably most interested in. I mean the hot springs and geysers. Yellowstone has the greatest hot springs and geysers in the world, and I want to explain just a few things about them. I shall take up the hot springs first.

The white substance which you see deposited on the hot spring formations at Mammoth is called travertine. It is composed largely of calcium carbonate, with some magnesium carbonate and some slight traces of sulphur, potassium, and other elements. The travertine is brought to the surface by a process which I shall explain by analogy. You know that in certain sections of the country they mine salt by pumping superheated steam and water down to the salt beds, thus forming a saturated solution of salt. this solution is pumped to the surface the water evaporated off, and the salt remains. Now, that is just about what is happening here, except that there is a different salt involved, and of course all phases of the process here are natural. Surface water seeps down thru the cracks and fissures in the earth and finally encounters heated rock layers, far below, or steam issuing from still deeper beds of lava. There are several considerations relating to the source of heat in these rocks. One is that the heat comes from lava flows or great intruding masses which were covered over by succeeding flows so quickly that they never cooled. We have not the

time to discuss this problem, - it would involve a lecture in itself, - I mention the main points only regarding this heat supply. The water rises to the surface as in ordinary cold water springs, but being hot and containing some carbonic acid gas as well, it readily dissolves the limestone thru which it passes, - the old sedimentary rock layer which I have spoken of. Coming to the surface the hot water evaporates very quickly, leaving behind the limestone deposit known as travertine. Some precipitation of this travertine is also due to the cooling of the water and the action of microscopic plants called algae. There is always much speculation among tourists as to what causes the coloring on the hot spring terraces. One might assume, at first, that the coloring is due to mineral deposits, but this cannot be, because the coloring disappears as soon as the spring becomes inactive, whereas mineral coloring would be permanent. The explanation is that the coloring here is not due to minerals at all, but is formed by different varieties of microscopically small hot water plants, - the algae. The variety of color is due to the fact that different varieties of algae grow in different temperatures of water. The algae follow their temperatures very closely, and this accounts for the uniform gradations of coloring in all of the springs. The sulphur colored algae will be found in the hottest water, and then the colors shade off gradually into yellows and browns and brick-reds, as the water cools. The coloring is probably the most beautiful feature of the hot springs terraces. The springs are constantly shifting and changing their activity, and the algae disappear when the spring dries up. Many old, inactive terraces, bleached white or weathered to a gray, cover Terrace Mountain.

The geyser does not differ much from the hot spring except in the structure of the tube which holds the water. In the case of the hot spring, this tube is either large enough, or straight enough, or porous enough, to allow circulation of water in the tube itself, which keeps all of the water at a more or less even temperature and the spring bubbles over very peacefully at the surface. In the geyser, however, the tube is narrow or crooked, of such a shape as to retard these convection currents and is steam tight. The water thus heated by steam or by contact with the heated rock below is therefore confined there until it eventually becomes so hot that it flashes into steam. The expansion of this steam throws the water out of the tube, - this is the spouting of the geyser which you see. The deposit around the geysers is also different from that of the hot springs. It is a hard, flinty substance, mostly hydrous silicon dioxide, and it is deposited very slowly, whereas the travertine of the hot springs deposits rapidly and is a soft substance, easily broken. The hot springs and geysers are active winter and summer.

The Grand Canyon of the Yellowstone is, of course, the climax to the park's magnificent scenery. Tourists are so taken up with its falls and beautiful tints that its geological significance is often overlooked. The canyon is a great gorge which has been cut down thru the lava flow by the Yellowstone River. The lava was gradually decomposed by erosion, perhaps aided by the hot springs and steam vents there, and the constant wear and friction of the river cut out of the gorge. The coloring in the canyon is due to minerals. The lava flows contained many minerals and each of these ores takes on its particular hue as it is decomposed while exposed to the elements. We sometimes forget how the forces in nature have worked steadily for centuries preparing wonders which appeal too often to the eye and not to our understanding.

Which brings me to say that the only people who have a real appreciation of the Yellowstone are those who go about understanding. I know that the word study has an unfortunate connotation for some people who are on vacation, - they do not like the idea of studying about anything while traveling. All, however, are invited to go over to our Museum and browse around. The National Park Service has people there who are working hard to supply information and service and who are well informed and glad to answer questions. Rangers on duty there will show you the bird and flower exhibits and explain the geological exhibits of specimens. The Government sells pamphlets there at a nominal cost which pertain to many of the surprising things about your park. I cannot impress upon you too much the value of visiting our Museum and taking advantage of what the people there have prepared for you and all of the park visitors.

Just one thing more. We rangers are supposed to be, in a way, recorders of the public sentiment. We are the government men with whom you will come in closest

contact as you go thru the park. And we are anxious to get your impressions of things here. What do you think of the service you are getting in the park, of the organization and the management of the park ? Why, you people probably do not realize how much the whole spirit of the administration of the park is that what the people want, within reasonable limits, is exactly what they ought to have. And the best judge as to how we are succeeding is the public itself. That is why we want your reactions to things. Do not hesitate to make suggestions to your rangers. Mr. Albright, the superintendent, has repeatedly said that he welcomes suggestions more than compliments, because they show best how the service may be improved to make things more enjoyable for you. From the very nature of our office we are anxious to please you.

If any of you have such suggestions to offer or any other questions to ask I shall be glad to talk to you immediately after the lecture.

* * * * * * * * * * * * * * * * * *

VOLCANIC ACTIVITY IN THE YELLOWSTONE REGION

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

The average visitor to the Yellowstone accepts the fact that the region is of volcanic origin and as casually takes it for gramted that this activity belonged entirely to a bygone geological period. However, Brigadier-General Chittenden and others of like sincerity and diligence have concluded from the early writings and traditions that there was volcanic activity in the Rocky Mountains as late as the beginning of the nineteenth century.

In 1871 Mrs. Frances Fuller Victor published a book (copyrighted 1869) entitled "The River of the West" which is a sort of a biography of a pioneer trapper named Joseph Meek. In 1829, when the Rocky Mountain Fur Company withdrew from the field then dominated by the Hudson Bay Company, Meek, who had been in the employ of the former under Captain William Sublette (for whom Yellowstone Lake was once called), was lost from his comrades and wandered for several days until he was found starving and half crazed by two of his party. There is no doubt that he was at one time in the hot springs district of the park, for he describes in his diary a "whole country smoking with vapor from boiling springs, and burning with gases issuing from small craters each of which was emitting a sharp, whistling sound . . . . . Interspersed among these on the level plain were larger craters some of them from four to six miles across. Out of these craters issued blue flames and molten brimstone."

Allowing for possible exaggeration, Meek's assertion that fire and brimstone issued from these craters is not wholly unsubstantiated. Writing in 1811 Henry M. Breckenridge says: "Mr. Lisa informs me that about sixty miles from his fort (at the mouth of the Bighorn) there is a volcano that actually emits flames." Manuel Lisa, here referred to, was a celebrated trapper of the first quarter of the nineteenth century. He, it was, who met John Colter as he was on his way to civilization from the first winter spent in the Rockies after leaving Lewis and Clark, and persuaded that frontier hero to turn his back on the settlements for the third time and to go again into the wilderness. So, indirectly, Lisa was the cause of Colter's visit to the Yellowstone, for his first measure after selecting a site for his establishment at the mouth of the Bighorn, was to dispatch Colter to the surrounding tribes for the purpose of bringing them into the fort for trade. It was while on one of these expeditions that Colter traversed part of the Yellowstone region.

It remained for Washington Irving to give the weightiest evidence on the point of active volcanoes. In describing the expedition of Robert Stuart, he states that on the first of October, 1812, "they. . . .beheld below them a plain about twenty miles wide, bounded on the opposite side by their old acquaintance, the Pilot Knobs, (early name for the Teton mountains), those towering mountains which had served Mr. Hunt as landmarks in part of his route of the preceding

year. . . . . .Those of the party who had been across these mountains pointed out much of the bearings of the country to Mr. Stuart. They showed him in what direction must lie the deserted post called Henry's Fort, where they had abandoned their horses and embarked in canoes, and they informed him that the stream which wandered through the plain below them fell into Henry's River, half way between the fort and the mouth of Mad or Snake River. The character of all this mountain region was decidedly volcanic; and to the northwest, between Henry's Fort and the source of the Missouri, Mr. Stuart observed several very high peaks covered with snow, from two of which smoke ascended in considerable volumes, apparently from craters in a state of eruption." (Irving: Astoria, Chap. xiv., pp. 353-4) Dr. Frank H. Bradley, Chief Assistant Geologist, with the U. S. Geological Survey of 1872 says, apropos of the foregoing quotation: "The peaks of the westward continuation of the range of which Sawtelle's Peak forms the eastern termination show such structures as seen from a distance, as to indicate that they also are of volcanic origin. . . . It is not known to any of the present inhabitants of the region that any of these volcanoes have been active in modern times." He then refers to the above quotation, and goes on "The location indicated would apply well to peaks of the range now under consideration (Sand Hill Mountains). It is hardly to be supposed that . . so experienced a mountaineer should have been deceived by timber fires, or that such fires should occur near the summits of peaks covered with snow." (Hayden: Sixth Annual Report of the United States Geological Survey of the Territories, 1873, p. 227) Thus does the geologist and geographer bear out the tale teller in the matter of location.

* * * * * * * * * * * * * * * * * *

ANCIENT GEYSER BASIN IN CROSS SECTION

By J. E. Haynes, Acting Director,
Yellowstone Park Museum

Approved by: Superintendent H. M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist.

In the Firehole Canyon, where the new road is now being built, there was discovered in 1925, by Ranger Parks of Madison Junction Ranger Station, a remarkable cross section of a geyser basin of prehistoric age. Even now, on frosty mornings, steam is seen issuing from crevices along the Firehole River at the base of the rhyolite lava cliff which rises 600 feet perpendicularly above the river. Unquestionably the top . . surface of this cliff was eroded many feet during the ages through which by slow erosion the river cut the great cross section seen today. The irregular areas on the side of the cliff were, no doubt, at one time chambers filled with hot water, but no one can tell whether the surface manifestations were quiescent hot springs, erupting geysers, a transition from one to the other, or a combination of both.

Before the cross section forming the present cliff was cut, obsidian sand and other surface materials were washed into the orifices of these chambers, finally filling them. Silicious cement has made a hard rock of this debris - a layered sand rock, totally different in both texture and origin from that of the cliff itself, yet so like it in color that it escaped . . discovery until fifty-three years after the Yellowstone National Park was established (1872).

Interesting, indeed, is that fact that this revelation is on the east wall of National Park Mountain, named to commemorate the birth of "The National Park Idea" in the then nearby camp of the Washburn Party in 1870. National Park Mountain marks the resting place, and actually reveals one of the pioneer geys basins of Yellowstone National Park, which Park today has the most famous active thermal springs and geysers in the world.

THERMAL DEPOSITION IN YELLOWSTONE NATIONAL PARK

By J. E. Haynes, Acting Director,
Yellowstone Park Museum

Approved by: Superintendent H. M. Albright,
Dr. A. L. Day, Geophysical Laboratory of the Carnegie Institution,
Dr. F. E. A. Thone, Science Service, Washington, D. C.
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Ranger Charles Phillips, Yellowstone Park.

Ranger Charles Phillips, stationed during the winter of 1925-26 at Old Faithful, is the author of an article published in the Yellowstone Nature Notes, Vol. 111, No. 2, of February 28, 1926, wherein he observes that after comparatively low temperatures (20° below zero) there is an unusual mineral deposit in the runoffs that carry the water away from Old Faithful Geyser; also that if the dissolved silica can be frozen out it is possible that the rate of growth of the high mounds of many of the geysers is not as slow as had been originally calculated.

This article attracted the attention of Dr. Frank E. A. Thone, now with the Science Service in Washington, D. C., who was formerly Park Naturalist in Yellowstone National Park, who transmitted to us the following extracts on this subject, obtained from Dr. Arthur L. Day, Director of the Geophysical Laboratory of the Carnegie Institution of Washington. The extracts are from an unpublished manuscript by the late Dr. Arnold Hague of the United States Geological Survey, which was written in the early 90's.

"Thruout the autumn and spring these waters, on freezing at night, dsposit a considerable amount of mineral matter which in the aggregate must add largely to the precipitated silica.

"Demijohns of geyser water which has stood for one or two years at moderate temperature without any apparent change, failed to precipitate silica. In experimenting upon these waters in the laboratory it was noticed that on reducing them nearly to freezing point no change took place, but on lowering the temperature there occurred an abundant separation of free silica. The waters frozen in this way were collected from .Coral Spring, Norris Basin, and Taurus Geyser, Shoshone Basin."

It might be proper here to consider the various names by which the prevailing silicious deposits in the park are known. Chemically, silica is silicious dioxide, or silicic anhydride, (SiO_2), occurring in nature in crystalline form as quartz, and in amorphous form as opal. Geyserite is a hydrated form of silica, deposited in white or grayish masses, porous, filamentous or scaly, around most of the hot springs and geysers. It is known also as silicious sinter, which has this chemical formula $SiO_2\ nH_2O$ (the "n" is variable).

Notwithstanding the fact that Dr. Hague has used the word "silica" in the above unpublished manuscript written in the '90's, he was particular to say in 1914, when he last visited the park that the deposits of silicious sinter there which are practically all hydrous, are not usually spoken of as silica, since this latter term is used when anhydrous silica such as quartz is referred to. It is therefore advisable in our reference to the geyser formations in the Upper, Lower, Midway, Shoshone, West Thumb Geyser Basins, and elsewhere, to use the terms geyserite or silicious sinter.

In geyserite, silicious sinter, slight traces of oxides of iron and other impurities actually color the rock various shades of yellow and pink. The forms of geyserite vary with the methods of deposition. Where the flow is more or less continuous the deposit forms in translucent layers, resembling mother-of-pearl in appearance. Where the water splashes in drops the sinter is beaded. Where the water is ejected in a fine spray it takes the form of small spines. Many craters exhibit all three types of geyserite. When the nature of the flow changes, intermediate forms develop and often the surfaces are striking in both their variety and beauty.

At Mammoth Hot Springs the deposits of calcium carbonate are not known as lime or limestone, which terms do not apply specifically to calcium carbonate formed from hot water. Therefore the correct term to use for the calcium carbonate de-

posits is travertine, calc-sinter or calcium carbonate. This white travertine, varying from soft and chalk-like to hard and semi-crystalline, is deposited from waters holding lime in solution. The coloring on these deposits is due to algae and to certain bacteria which are low forms of plant life.

Sulphur occurs in a free state on the terraces at Mammoth, chiefly around the springs on the highest level. Free sulphur is also found on the park plateau, notably at Crater Hills, Norris Basin, and Sulphur Mountain. In the geyser basins pyrite (disulphide of iron FeS_2) often gives the sinter a pearly-black lustre and it sometimes forms a scum over muddy pools, giving the surface a metallic sheen when viewed in bright sunlight. At Verma Spring in the Norris Basin it occurs with free sulphur in the form of floating black globules which may have developed over bubbles of carbonic acid gas. When seen in suspension in the spring or coated on the bottom or sides its appearance is usually black. Pyrite, in its characteristic crystalline form is popularly known as "fools gold".

Arsenic, tho small in quantity, occurs in association with geyserite thruout the park. It seems to be especially abundant in the Norris Basin where it is found in combination with sulphur. Two pools in this vicinity are named for these compounds of arsenic, realgar (AS_2S_2) and orpiment (AS_2S_3). The gray-green deposits around a few vents in the Upper Geyser Basin may be scorodite (arsenate of iron) referred to by Hague. Tourists who shy at the idea of arsenic in the park waters may be reassured by the fact that arsenical springs are among the most valuable in the treatment of nervous diseases.

Factors contributing to or associated with the depositing of geyserite and travertine are: (1) cooling (2) evaporation (3) freezing of the water (4) removal of the carbon dioxide gas from the water by the algae and by its escape due to heat and release of pressure. Some of this gas is extracted by the low form of plant life - the algae - which require it in their existence and development. We have no evidence that silicious sinter is deposited by cooling - but only through the agency of evaporation and freezing. (Allen)

Definitions and Rates of Deposition of Geyserite and Travertine.

Travertine; calc-sinter; calcium carbonate; $Ca\ CO_3$; varies from soft chalk-like to harder semi-crystalline masses (principally at Mammoth).

In certain runways from the hot springs at Mammoth it has been observed that travertine deposits very rapidly: 1/16th of an inch in three or four days. In others it is much slower, while articles allowed to remain in the still water of the pools for several days show practically no deposit, - in general it is safe to say that the more rapid deposition occurs where local evaporation is most rapid.

Geyserite; silicious sinter; hydrated silica; $SiO_2\ nH_2O$; white or grayish masses as hard as glass around most of the hot springs and geysers, except at Mammoth.

Tests have also been made to ascertain the rate of deposition of geyserite. Comparison of the appearance of the Grotto Geyser formation, Old Faithful Geyser Crater, Castle Geyser Cone, and several others, in photographs taken over forty years ago, with features as they are today, discloses no apparent change. Articles placed in the waters for several weeks take on slight deposits, but it is estimated that only in the places where they form most rapidly is a rate of deposition of 1/16th of an inch a year reached, except, possibly in basins near frequently erupting geysers where geyserite is frozen out of the water between eruptions during the winter months; but this deposit is largely washed away. The average rate, however, is considerably less than 1/32nd of an inch a year.

LIFE ZONES OF YELLOWSTONE PARK

By Charles Phillips
1890 - 1927

It is a matter of common observation that in climbing a high mountain the plant and animal life alter in character as the traveler ascends and grow gradually more sparse, the mammals and most of the birds disappear, the trees and shrubs become more and more dwarfed, until after a fairly definite point there is nothing left at all save the scanty mosses and lichens that reach the highest summits. It is also a matter of observation, altho obviously less common, that in traveling from south to north the same phenomenon is apparent if the distance traversed is great enough. Thus in climbing from Gardiner to the summit of Electric Peak we will encounter changes in the fauna and flora that parallel those we would meet in a journey at sea level from central California to the north coast of Alaska. This parallel early attracted the attention of travel and scientists and the precise relationship between latitude and altitude as they affect the distribution of plant and animal life has long been known.

Let us review briefly the fundamentals of climate that we may have a background against which to view this distribution. That the earth is hotter at the equator than at the poles and that its surface is divided into five belts or zones of varying climate is perhaps the most elementary fact in geography. It will be recalled that the exact position of the climatic zones is established by the inclination of the axis upon which the earth rotates daily to the plane of its annual journey around the sun. This angle has varied several degrees during the time in which it has been known (since about 1000 B. C.) and the position of the five zones has altered correspondingly. At present it is $23^{\circ}27''$, so nearly $23\frac{1}{2}^{\circ}$ that the latter figure is sufficient for all except the most accurate calculations.

This inclination of $23\frac{1}{2}$ causes the apparent position of the sun to vary with the four seasons of the year. At the vernal and autumnal equinoxes (usually March 21st and September 21st) it is directly over the equator. At the summer solstice (June 21st) it is $23\frac{1}{2}^{\circ}$ north of the equator or in other words, it is overhead at $23\frac{1}{2}^{\circ}$ north latitude, the tropic of Cancer; at the winter solstice (December 21st) it is overhead at the Tropic of Capricorn, $23\frac{1}{2}^{\circ}$ south latitude. Again, at the summer solstice the sun is visible not only at the North Pole but also for a distance of $23\frac{1}{2}^{\circ}$ south from the pole. On the same date it is invisible at the South Pole and for a distance of $23\frac{1}{2}^{\circ}$ north of it. These two imaginary lines $23\frac{1}{2}^{\circ}$ south of the North Pole and north of the South Pole determine the Arctic and Antarctic Circles. At the winter solstice these conditions are exactly reversed.

Here, then, we have the astronomical basis for our zones of climate. The Torrid Zone or Tropical Zone, is the belt of the earth's surface where the sun is directly overhead at least once a year; its north and south boundaries are the Tropics of Cancer and Capricorn, respectively. The Frigid Zones, or Polar Zones, are those caps around the North and South Poles where the sun is visible without setting for a continuous period, ranging from a day to six months with the proximity of the observer to the pole, and when the sun is continuously invisible for an equal length of time. The Arctic and Antarctic Circles form the south and north boundaries of the polar zones of the same names. Between the tropical and polar zones are the so-called Temperate Zones (better Intermediate Zones for their extreme changes of temperature are anything but "temperate") Here the sun is never directly overhead and on the other hand never continuously visible or invisible for twenty-four hours or more.

If the earth were stationary and if its surface were uniformly all land or all water, each of these zones would have a characteristic climate which would be the same for all points equally distant from the equator. Since this is not the case there are many factors that alter the natural climate of each zone to such a degree that the isotherms or lines of equal temperature cross and recross their corresponding parallels of latitude many times. (1) The land surface of the earth is largely in the northern hemisphere which makes for extremes of temperature, i.e., hotter summers and colder winters than the position of the sun alone would cause. (2) The rotation of the earth divides the winds that would normally blow toward the equator or toward the poles toward the east or west according to their position on the globe, producing marked differences of climate on the east and west coasts of continents. (3) The sun's heat on tropical seas develops ocean currents of warm water that move away from the equator and have a warming influence on the lands along whose shores they flow. (4) The Atlantic Ocean widens as it extends northward allowing an abundant influx of cold water from the polar seas to take the place of the warm water north-

ward while the Pacific tapers to the narrow Bering Strait that admits only a small quantity of ice water from the north. These last two factors carry temperature conditions on the Pacific coast of North America above the Arctic Circle while on the coast of Newfoundland on the Atlantic side they bring down Arctic conditions almost to the 45th parallel, the point half way to the equator.

It is supposed then that the mathematical boundaries of the torrid, temperate, and frigid zones do not coincide at all with the boundaries established by the lines of equal temperature or isotherms. Since temperature is by far the most important factor in the distribution of living things, it is the temperature zones that the naturalist must use as a basis for his life-zones.

To those who first gave thought to these matters it seemed obvious that the controlling factor in the distribution of life was the freezing point of water. Accordingly they established the Arctic Zone as that portion of the earth where the soil is perpetually frozen below the surface so that the growth of trees and deep-rooted vegetation is impossible. They designated as the Tropical Zone that region where frost is unknown and the season of growth is continuous. The Temperate Zone embraced the intervening area. Thus the southern limit of perpetual frost was regarded as the biologic Arctic Circle and the northern limit of no frost as the biologic Tropic of Cancer.

However, later investigation by the Biological Survey has shown that, outside the tropical region where the period of growth is continuous, the influence of temperature is not operative throughout the year but only at certain seasons. On the basis of the Survey's data Merriam has formulated two Laws of Temperature Control:-

I. The northward distribution of animals and plants is governed by the sum of the positive temperature for the entire season of growth and reproduction.

In other words, the crucial temperature for a species is not that at which it can merely maintain the existence of its individuals, but at which they can grow and multiply. The rate of growth of plants is dependent on the quantity of heat of their environment; in a hot-house the rate is greatly accelerated while if the temperature is low growth is retarded. In a region where the climate is so cold during the period of growth and reproduction that plants cannot mature sufficiently to ripen to their seeds the species must automatically perish. In a like manner, animals require sufficient heat not only to stimulate the reproductive process in adults but also sufficient warmth for a long enough period to enable their young to survive early infancy. A minimum of 43° F has been assumed by Merriam as marking the beginning of physiological activity in plants and reproductive activity in animals. To determine the"sum of positive temperature for the season of growth and reproduction" in any locality the number of degrees of normal daily heat above 43° F have been added together, beginning when the normal daily temperature rises higher than that figure in the spring and continuing until it falls to the same point in the autumn.

II. The southward distribution of plants and animals is governed by the mean Temperature of a brief brief period during the hottest part of the year.

Here it is the adults rather than the young that determine the species distribution for the young of a species can normally thrive in a temperature that would be inimical to the parents. Nearly related plants and animals vary widely in their ability to withstand heat for protracted periods and this makes for great difference in their southward distribution.

Merriam in formulating his law determined upon a period of six weeks as the most suitable for all latitudes and it is on this basis that his life zones have been established.

These laws make it apparent that from a biological point of view the older conceptions of torrid, temperate and frigid zones would have to be discarded completely. Upon the basis of the most outstanding and fundamental differences in its plant and animal life, he has divided North America into three Regions, the Boreal ("northern"), the Austral ("southern") and the Tropical. Each Region

is further divided into Zones each of which has a characteristic and fairly uniform set of climatic conditions and which for that reason are regarded as the units of distribution. The Boreal Region includes the Arctic-Alpine Zone, the Hudsonian Zone and the Canadian Zone, each of which is theoretically transcontinental in extent but is actually more or less broken through the agency of other factors. In the Austral Region we have an east and west sub-division on the basis of humidity. The line of demarcation is approximately the 100th meridian. West of this meridian the Austral Region comprises the Transition, the Upper Sonoran and Lower Sonoran Zones; east of it these zones are called the Alleghenian, Carolinian and Austroriparian (Lousianian). As the Tropical region lies chiefly in Mexico and Central America and enters the United States only at the extreme tip of Florida its zones need not concern us.

Not all these zones are equally well-marked. In general the alternate ones are distinctive while those occupying the intermediate positions are transitional in character. The following table shows the relation of these life zones to each other and to the geographic zones.

Life Zones		Geographic equivalent
	(Transcontinental)	
Boreal Region	Arctic-Alloine Zone	Frigid Zone
	Hudsonian Zone	Temperate Zone
	Canadian Zone	
	(Western-arid) (Eastern-humid)	
Austral Region	Transition Zone - Alleghenian Zone	
	Upper Sonoran Zone - Carolinian Zone	
	Lower Sonoran Zone - Austroriparian Zone	
Tropical Region	Only one zone represented north of Mexico - Floridian Zone	Torrid Zone

The Arctic-Alpine Zone lies wholly above the limit of trees and is the most distinctive of all the life zones. It is not only transcontinental but circumpolar as well; the uniform climatic conditions of the polar regions as well as their comparative proximity have developed an almost identical fauna and flora on both sides of the Atlantic. Lack of sufficient data have made it impossible to determine the quantity of heat that is received by this zone during the growing and breeding season but its southern boundary, the limit of trees, is so well marked that it establishes the line of division satisfactorily. This southern boundary is found to coincide practically with the isotherm of 50° F for the six consecutive hottest weeks of the year.

The Hudsonian Zone is less definite than the preceding and is to be regarded as intermediate in nature between it and the following. The Hudsonian marks the transition from the coniferous forests of the Canadian to the treeless wastes of the Arctic-Alpine and is characterized by its dwarfed timber, growing gradually more stunted as the Arctic is approached. Here again, the distinctive temperature is not well known, but its southern boundary may be regarded as the summer isotherm of 57° F.

The Canadian Zone is distinguished by the high development of its coniferous forest and a correspondingly well specialized fauna and flora. It is pre-eminently the home of the so-called "big game" and the typical fur-beare. It has a numerous permanent bird population and an even larger one of migrants who spend the breeding season there. Its southern frontier is the lower edge of the northern pine, spruce and fir belt which corresponds to the isothermal line of 64½° F. in midsummer.

In the three zones of the Austral Region we find rainfall entering as a factor. The rain-bearing clouds from the Pacific have to pass over both the Sierra Nevada and Cascade Mountains and the Rockies and by the time they have reached the Great Plains they have yielded most of their moisture. East of the 100th meridian this aridity is redeemed by the so-called cyclonic winds, warm damp winds from the Gulf of Mexico, that are caused by the movement of areas of high and low pressure across the continent. The line west of which the annual precipitation is less than 25 inches divides the two halves of the Austral Region. As stated, it is approximately the 100th meridian and is the point at which the prairie pass into the plains. East of this line the zones are designated Alleghenian, Carolinian and Austroriparian; west of it Transition, Upper and Lower Sonoran.

As its name indicates the Transition Zone is a "no man's land" between the typical north and the typical south and its fauna and flora partake of the characteristics of both. Several other zones are transitional in character but in no other is the element of change so striking as in this one where the deciduous forests merge into the coniferous. Merriam states that Transition species require a total quantity of 10000° F of heat during the breeding season (i.e. above 43° F) but cannot endure a summer temperature that exceeds 71½° for six consecutive weeks.

The Upper Sonoran Zone includes the typical Great Plains of the literature of the West. It is for the most part semi-desert and the only impression it leaves on the casual traveler is that of endless mile after mile of sage brush and cactus that stretch monotonously in every direction to the horizon. Its few trees are along the water-courses and mark their welcome presence from afar. The total quantity of heat received by this zone in the season of growth and reproduction is 11500° F while the isotherm of 79° that marks the greatest heat its species can endure through the hottest season, defines its lower limit.

The Lower Sonoran Zone has no representation in thet part of the west in which we are interested and so we may dismiss it briefly. It is an intermediate Zone and in it elements of both the Tropical and Upper Sonoran Zones often overlap. According to Merriam, Lower Sonoran forms require a minimum of 18000° F of heat for growth and reproduction while the summer isotherm of 86° may be regarded as the line that divides it from the Tropics.

In general it may be said that species are confined to zones and that it is the larger groups, genera, families, etc., that are distributed over regions. This is especially true of plants, less so of mammals and least of all of birds whose space-annihilating power of locomotion enables them to circumvent to some extent the laws that bind their less mobile fellow-creatures. When a species extends over several zones the different climatic factors usually impress changes enough upon it to break it up into a number of sub-species. In the case of mammals and birds especially the influence of climate is very marked both on color and size. These relations may be expressed in two laws, (1)the depth of coloration of a species increases with the humidity and decreases with the aridity of its environment and (2) the size of a species increases as its distribution extends northward and decreases southward. In the case of exceptionally plastic species like the Song Sparrow, Flicker and Screech Owl these influences so modify the parent stock that the most divergent forms must be regarded as distinct species altho every stage of intergradation exists between them and the original type.

So far our discussion has dealt with the distribution of life theoretically at sea-level and our life zones were wholly on a basis of latitude. Before taking up what relation altitude might have to these zones let us consider how elevation modifies the climate of a locality.

Air, being like all gases, highly elastic, is much denser at sea level where it is compressed by the weight of the air above it, than at an elevation. Thus at 19000 feet it is only half as "thick" as at sea level. The polar regions are cold even at sea level because they receive so little of the sun's heat; under the equator a sufficient elevation with its correspondingly thin atmosphere achieves the same result because the thinner air absorbs less of the sun's heat and also retains less of the earth's heat it receives by radiation from below. The average fall in temperature with increase in altitude is about 800 times as rapid as its fall with increase of latitude, or in other

words, one mile of ascent into the air is equivalent in drop of temperature to a journey of 800 miles toward the North Pole. Here in the Rockies the average rate of decrease of temperature is 1° for each 250 feet of rise. On that basis the difference of elevation between the Gardiner gate and Electric Peak is equivalent to a temperature difference of over 23°, a difference which by Merriam's law would embrace within its limits four life zones and a fraction of a fifth.

The character of the elevation however, makes a profound difference on its temperature. An isolated peak with its constant change of air and more complete radiation is much colder than a plateau of the same elevation. When these two elements are found in conjunction, i.e., when mountains rise from a high base level, the surrounding plateau exerts a modifying influence on the peaks above it. Thus, timber-line on Mt. Rainier, an isolated volcanic cone rising from a low base in approximately the same latitude as Electric Peak, is more than 3000 feet lower than it is on the latter. Of no less importance as a modifying agent is the direction and angle of slope of the elevation. A south exposure whose angle of slope puts it at right angles to the sun's rays receives more solar heat than a flat lowland of equal area, but its thin atmosphere is not able to absorb and retain this greater amount of warmth. On the other hand a north exposure receives even less heat than a similar flat area which accounts for the often extraordinary differences of opposite sides of a mountain.

Life zones on the basis of altitude, being so much more compressed by the rapid changes of temperature noted above, are influenced by local factors that would be unnoticeable in those established by latitude. In addition to the warming influence of a high base level and the even more local factors of north or south exposures, streams and air-currents play an important role in determining zonal limits. Thus a cold mountain stream will carry a tongue-like extension of the Canadian far down into the Transition. So also will a current of cool air descending down a gulch or ravine while less often currents of warm air flowing up canyons from the heated plains carry lower zone forms into the higher.

As before stated, the extremes of elevation in the Yellowstone are sufficient to include within them four well marked life zones and traces of a fifth. The entire five from the Upper Sonoran through the Transition, Canadian and Hudsonian to the Arctic-Alpine are encountered in a climb the Gardiner Flats to the summit of Electric Peak. As this is not feasible except for practical mountaineers, the average tourist will find the ten miles between Gardiner and Swan Lake Flat interesting and instructive from this point of view. Equally so is the same distance from the summit of Mount Washburn to Camp Roosevelt. The first journey will take the traveler in a biological sense from the great plains into the middle altitudes of the Rockies, the second from the very crest of the Rockies down to the foot-hills. Of the five zones the Canadian is far and away the most extensive; it covers nearly nine-tenths of the park while the other four divide the remaining tenth between them. A more logical division from the tourist point of view, however, would be that of the mileage included by each zone on the Park roads. While precise statements are difficult and apt to be misleading, we may assign on that basis the following propostions of the entire system of roads within the Park; Upper Sonoran, less than 1%; Transition, 25%; Canadian, 70%; Hudsonian, 3%; Arctic-Alpine, less than 1%.

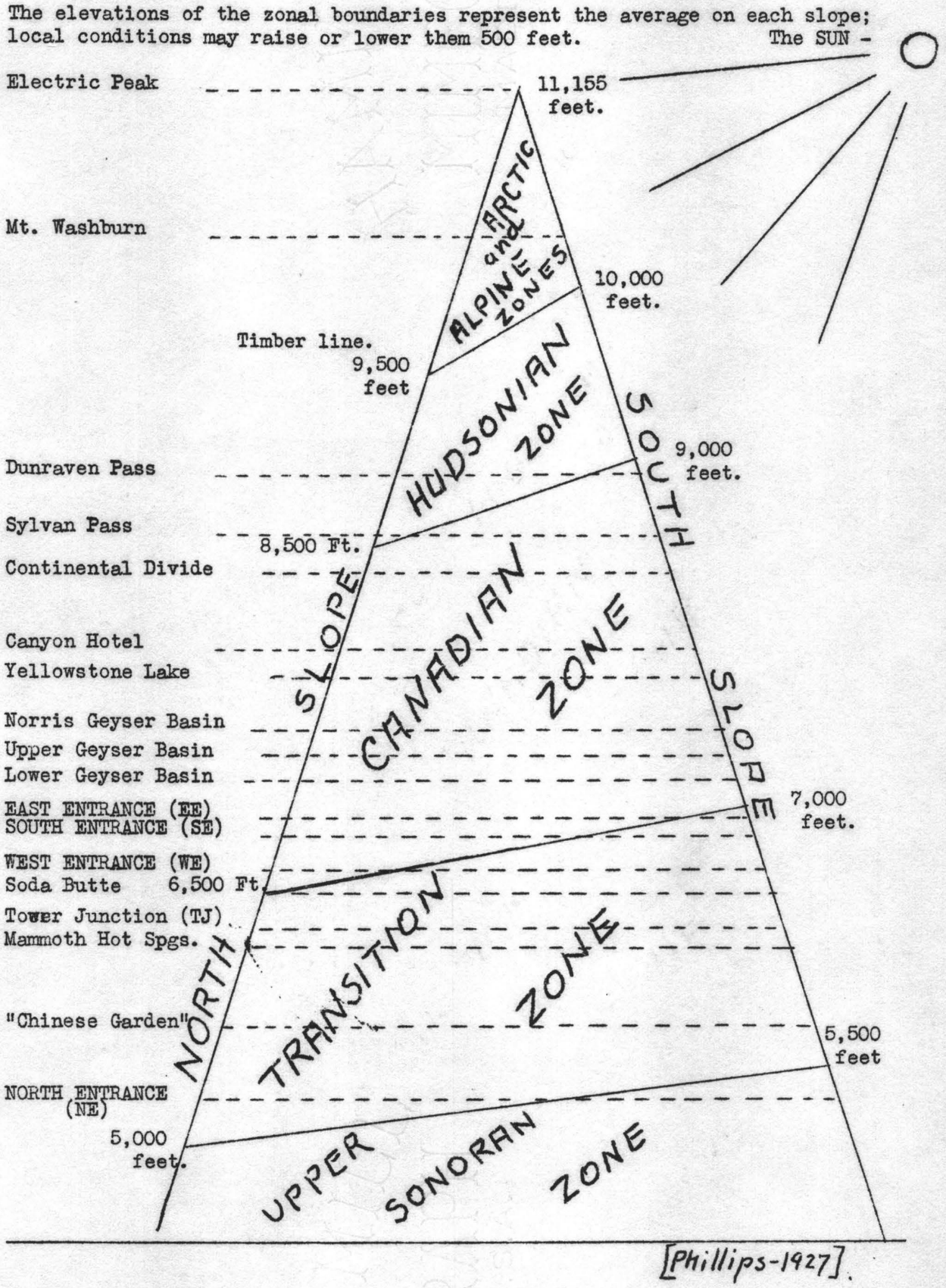
The Upper Sonoran Zone is represented in the Park by a mere fringe that covers a couple of square miles just inside the north gate. The distinctive Sonoran element of a large part of even this small area has been destroyed by irrigation and cultivation of forage for the antelope. It may be best studied on the flat between the Gardiner and Yellowstone Rivers on the site of the former rifle range. Traces of the Sonoran extend up to the mouth of the Gardiner Canyon and the Third Canyon of the Yellowstone but all disappear at 5500 feet. Outisde the Park the typical Sonoran is found at Cody at the east entrance, at a point half way between Lander and Dubois on the south and as far up the Yellowstone as Big Timber on the north side. Within the Park it is represented chiefly by a few shrubs, among them greasewood, salt-bush, hop-sage (grayia), skunk-bush and several species of rabbit-bush.

Several typical Sonoran birds are found in the Park as far up as the lower Transition, for example, the western morning dove, lazuli bunting, western lark sparrow and western marsh wren. The Arkansas Kingbird and Bullocks oriole,

LIFE ZONES IN YELLOWSTONE NATIONAL PARK

By Charles Phillips

The elevations of the zonal boundaries represent the average on each slope; local conditions may raise or lower them 500 feet.



[Phillips-1927].

both of which have been credited to the Park, are more distinctive of this zone. The prairie rattle-snake which has been reported just within the north gate, is a characteristic Sonoran form altho it is occasionally found in the lower part of the Transition in Montana.

As before stated, the Transition Zone (5000-5500 feet to 6500-7000 feet) occupies a minor fraction of the Park's area but as the north entrance road, the Mammoth - Tower Fall road, the Cooke City road to a point several miles above Soda Butte, as well as the west and south entrances and the Gallatin and Bechler River valleys all lie within it, it assumes an importance out of proportion to its square miles. This zone is most conspicuously differentiated along its upper border where the open sage-brush slopes give way to the evergreen belt of the Canadian. In the mountains where the vertical contraction often brings several zones within the field of vision this passage from the decidious to the coniferous forest is very striking and produces some of the Park's finest landscape effects. The Transition as a whole is .. marked by a wide variety of forms, both plant and animal; in addition to its extensive native population its transitional character makes it a suitable habitat for many species whose natural home is either north or south of it. Here in the Park it is also characterized by a ultiplicity of species altho many of them are but sparsely represented.

In the Yellowstone the typical trees of the Transition are decidious, the narrow leaved cottonwood, Rocky Mountain birch, alder, mountain maple, etc., of the conifers the Rocky Mountain cedar is also represented in the Sonoran while the Douglas fir is equally divided between the upper Transition and lower Canadian. Sage brush, in one form or another, is found all through this zone and as high as the lower Canadian; the Transitional has several characteristic species altho an examination is necessary to distinguish them.

Birds in this zone are represented by numerous species but only a few are abundant. Of the following Transitional species, the more characteristic are for the most part rather uncommon while the more abundant are occasionally found in the Canadian; great blue heron, avocet, Columbian sharp-tailed grouse, sage grouse, ferruginous rough-legged hawk, prairie falcon, saw-whet owl, Rocky Mountain screech owl, Lewis woodpecker, white throated swift, king-bird, western crow, yellow-headed blackbird, thick-billed redwing, Brewer blackbird, pale goldfinch, western vesper sparrow, Brewer Sparrow, Mountain song sparrow, slate-colored fox sparrow, green tailed towhee, white-rumped shrike, western tanager, yellow warbler, western yellow-throat, sage thrasher, cat bird, rock wren, pygmy nuthatch, willow thrush, and western bluebird.

Most of the Transitional mammals are also found in the Canadian and may be more appropriately mentioned there. The prong-horned antelope and the buffalo, however, are characteristic of this zone altho the mountain buffalo apparently ranged much higher in the"old days". The infrequent white-tailed deer is also a member of this fauna but is of such sporadic occurrence that it is scarcely to be included in the "big game" of the Park. The bob-cat is rarely found in the higher parts of the Park and the badger only occasionally so. Typical lesser mammals are the sage-brush chipmunk, bushy-tailed wood-rat, grasshopper mouse, and the cotton-tail and white-tailed jack rabbits.

It will be recalled that mention was made of a tendency for birds and animals of the arid regions to be markedly paler than the same species in areas of greater rain-fall. As the Transition is the only zone in the Yellowstone (also the traces of the Sonoran) to be affected by lack of rain-fall, it will be interesting to note here a number of Park birds, chiefly Transitional, altho some are abundant in other zones, that are duller in coloration than the corresponding species of the more eastern states where the annual rainfall is over 25 inches; gray ruffled grouse, western morning dove, desert sparrow hawk, Rocky Mountain screech owl, desert horned lark, pale goldfinch, mountain song sparrow, western chipping sparrow, western tree sparrow, western vesper sparrow, western savannah sparrow, western lark sparrow, slate colored fox sparrow, western house wren, western marsh wren, etc.

While the Transition is no doubt most fascinating to those with some acquaintance with out-door life, the characteristic Yellowstone fauna and flora, as noted by the average tourist, as noted by the average tourist, are species that live wholly within the Canadian or at least have a numerous representation in it. The Canadian (6500-7000 feet to 8500-9000 feet) is the zone of the Park plateau and thus includes by far the larger part, 85% to 90%, of the Park area. Indeed,

hotel and camps tourists who are routed in Gardiner and out Cody and in Gardiner and out West Yellowstone as well as those auto campers who do not visit Tower Fall, see so little of the other zones that for them the Canadian is the whole Park.

Unlike the Transition the Canadian is richer in individuals than in the number of species represented. Of the trees, with the exception of the quaking aspen which is of local distribution in this zone largely in burnt-over country and the balsam poplar, found only on Stevenson Island in Yellowstone Lake, all are conifers. The lodge pole pine predominates overwhelmingly, covering 75% of the total forested area. The Engelmann spruce follows with 10% and the Douglas fir and alpine fir (the only true fir, known locally as "balsam") with 5% each; there is also a sprinkling of limber pine from the Transition and white-barked pine from the Hudsonian. In general, the lower Canadian is Douglas fir and lodge pole pine, the middle pure lodge pole and the upper a mixed forest of spruce and fir with some lodge pole. A few deciduous trees occur here as shrubs but the most typical shrubs are the various berries, huckleberries, blueberries, currants, gooseberries, raspberries, salmon-berries, service-berries, etc., the tiny red grouse or bilberry, a diminutive huckleberry, is most abundant.

The following birds may be regarded as representative of this zone, altho several extend up into the Hudsonian during the br eding season and others may wander to lower levels later in the summer; Barrow goldeneye, Richardson grouse, Arctic and Alpine three-toed woodpeckers, Rocky Mountain jay, black-headed jay, Cassin purple finch, American crossbill, pine seskin, western savannah sparrow, white-crowned sparrow, pink-sided junco, Lincoln sparrow, pileolated warbler, dipper (water ouzel), Rocky Mountain creeper, mountain chickadee, western golden-crowned kinglet, ruby-crowned kinglet, Townsend solitaire, olive-backed thrush and Audubon hermit thrush. The pink-sided juncos and white-crowned sparrows would undoubtedly take the palm for weight of numbers but the Rocky Mountain jays ("camp robbers") have a greater aptitude for getting in the public eye.

Of the big game the moose is the most exclusively Canadian altho the majority of elk and mule deer ("black-tail") spend the summer in this zone. The mountain lions and Canada lynx are also largely Canadian. Of the rodents the snowshoe rabbit and mountain lemming are the only ones confined to this zone; the beaver, muskrat and yellow-haired porcupine are equally characteristic of the zone below as are also a horde of their lesser relatives, the pine squirrel, flying squirrel, yellow-bellied chipmunk, white-footed mouse and red-backed mouse. The marten is the only member of the weasel family that is wholly Canadian; the mink and northern skunk are quite as, if not more, numerous in the Transition and to a lesser extent the otter and Arizona weasel.

Since its extermination on the plains the grizzly may be regarded as a Canadian species but it is inclined to wander widely and is often encountered in the Hudsonian and even above timber-line.

Above the Canadian lies the Hudsonian Zone, corresponding to the "land of little sticks", the Hudson Bay country. Here in the Yellowstone its alpine meadows and mountain parks surpass any part of the Park in sheer beauty. It extends from timber-line (9500-10000 feet, depending on exposure) down to 8500-9000 feet level. It is the narrowest of all zones below timber-line and is difficult to define on its lower boundary as its character is essentially Transitional, a thinning-out from the typical coniferous forest to none at all. This fringe of open timber is very conspicuous on all mountains rising above timber-line that are visible from the loop road. The road over Mt. Washburn passes through the Hudsonian both on the ascent and descent. As this journey takes the traveler up the north side and down the south side of the mountain it affords an excellant illustration of the effect of slope and exposure to the sun.

The Hudsonian is chiefly characterized by three trees, the white-barked pine, alpine fir and Engelmann spruce which, occurring at timber-line as dense carpet like mats, become tall and stately trees a thousand feet farther down and merge into the lodge pole forest at the lower limit of the zone. The crowning glory of the Hudsonian, however, is its alpine flower gardens. Here in the intense sunlight the blossoms actually touch each other, hiding the green of their leaves and stems under masses of blue, white or yellow, with touches here and there of red and pink, that are often acres in extent.

Characteristic birds are the Rocky Mountain pine grosbeak and Clark nutcracker altho the crow-like disposition of the latter to profit himself by association with man often brings him down to lower levels. Several species that belong more properly to the Canadian have some representation up here; alpine three-toed woodpecker, Rocky Mountain jay, white-crowned sparrow, pink-sided junco, Rocky Mountain . · creeper and western golden-crowned kinglet.

Of the mammals two dissimilar species are most closely associated with this region, the cony and mountain sheep. Grizzlies who haven't acquired a taste for hotel life often summer near timber-line and coyotes and wolves are frequent wanderers on the heights at all seasons except mid-winter. During fly-time many segregated herds of elk bulls come up from the low lands to avoid insect pests but they and also the three fore-going species are not to be regarded as characteristic of this zone.

The summits of the higher mountains in the Park, like those of the northern Rockies in general, are detached fragments of the circumpolar region; islands, one might say, off the Arctic circle. Their fauna and flora are similar to those of the treeless shores of the Arctic Ocean and collectively they form the Arctic-Alpine Zone. The auto tourist makes a slight acquaintance with it on the summit of Mt. Washburn. Hikers who climb Electric Peak have an opportunity to know it better but in both cases travelers are apt to make their stay a brief one for these heights are not considerate of the comfort of their visitors. In spite of its bleakness this region is full of beauty and fascination. It is a world apart, cut off from the world of green things beneath by the veil of clouds that often lie on the slopes below and the neighboring peaks stand out vividly near in the crisp, clear air.

Here, above the limits of the trees, all forms of vegetation are stunted for the season of growth is very short. They comprise chiefly mosses and lichens at the highest summits altho flowering plants flourish for a few weeks as far up as a thousand feet above timber line. In the lower part of the zone the ground is frequently matted with a dense growth of heath, cinquefoil and dwarf willows only a few inches high.

In the Yellowstone no animals live habitually in this zone; the mountain sheep and cony are often found here in midsummer and the few species that wander from the Canadian up the the Hudsonian may drift still higher into the Arctic-Alpine.

The only bird that has been found nesting in this zone within the Park is the pipit. However, one or more species of rosy finch may breed among the peaks of the Absarokas as the writer has seen the black rosy finch on the trail to Grasshopper Glacier in early summer. The white-tailed ptarmigan also will probably be found as a breeding bird on the Arctic-Alpine summits of the Absarokas as it has been found south of the Park on the higher peaks of the Medicine Bow Range and north of it in Glacier National Park.

But how, it may be asked, did these plants and animals from the far north become isolated on the peaks of mountains so distant from their native home ? That North American once had a milder climate than it now enjoys we have abundant proof here in the Yellowstone in the sub-tropical vegetation that is preserved in our fossil forests. Then came the Glacial Period, the age of ice and all forms of life both fauna and flora were forced to give way before the polar climate that the slowly advancing ice sheet brought in its van. In the Mississi pi valley the movements and limits of five separate invasions may be traced. Finally when more genial climates prevailed and the frigid area at the border of the ice sheet became warmer, the plants and animals that had made it their home were forced to seek a new environment, either because they could not adapt themselves to the changing conditions or because they could not withstand the competition of the more vigorous species that were now pushing up from the south. There were two alternatives, either to follow up in the wake of the retreating ice or to seek a similar climate on the mountain heights. The great majority followed the first course but a few took the second and today we find that while the forms of life on the summits of our mountains are not identical, they show a relationship to those of the Arctic regions that points to a common origin.

TABLE OF SURFACE TEMPERATURES OF HOT SPRINGS AND FUMAROLES

EXTRACTS

By Dr. Arthur L. Day; Dr. E. T. Allen,
Geophysical Laboratory, Carnegie Institution of Washington, D. C.

NOTE: Temperatures taken at the surface, - Centigrade thermometers.

	Temp. C.	Temp. F.
BOILING RIVER below Mammoth	48.5	119.3
MAMMOTH HOT SPRINGS		
Canary Terrace	65.2	149.36
Jupiter - south end (strongly boiling pools)	69.0	156.2
" " " " " "	71.7	159.98
" " " " " "	67.0	152.6
Mound Terrace (in most active springs)	66.3	150.34
Cleopatra Terrace top south end	71.0	159.8
Angel Terrace	65.0	149.0
Highland Terrace	71.5	160.7
White Elephant north end	59.2	138.6
Stydian Cave top	41.8	107.24
Cheops (so marked)	53.0	127.4
Orange Spring	60.0	140.0
Bath Lake	47.0	116.6
ROARING MOUNTAIN		
Spring in gulch north of center	92.7	198.86
Vent on slope near north end	92.5	198.5
NORRIS BASIN		
Foot of terrace near old lunch room steam	103.6	218.48
Hurricane Pool	90.0	194.0
Black Growler	140.0	284.0
Verma Spring	94.0	201.2
Valentine Geyser (toward end of eruption)	93.0	199.4
CHOCOLATE POTS BELOW NORRIS		
Pot near river side	54.0	129.2
" nearer the road	55.4	131.72
BERYL SPRING		
Spring proper	92.0	197.6
Steam vent close by	97.0	206.6
LOWER BASIN		
Mammoth Paint Pots	93.5	200.3
The Jet	94.0	201.2
Clepsydra	92.0	197.6
Indigo Pool	95.4	203.72
NORTH SIDE OF RIVER FIREHOLE BASIN		
Firehole Lake	80.5	176.9
Hot Spring emerging from sinter sheet above Black Warrior	94.3	201.38
Great Fountain	96.0	204.8

TABLE OF SURFACE TEMPERATURES OF HOT SPRINGS AND FUMAROLES
Doctors Day and Allen

BISCUIT BASIN		
Sapphire Pool	93.0	199.4
Jewel Geyser (just before reupting)	95.0	203.0
Jewel Geyser (just after erupting)	92.0	197.6
UPPER BASIN		
Morning Glory	77.0	170.6
Fan	93.0	199.4
Mortar	94.2	201.56
Chinaman	93.5	200.3
Topaz	94.8	202.64
Teakettle	94.0	201.2
Lion	93.8	200.64
Ear	94.2	201.56
Beach Spring	89.3	192.74
Giantess	94.2	201.56
Lioness	94.8	202.64
Sponge	95.0	203.0
BLACK SAND BASIN		
Handkerchief Pool	83.5	182.30
Emerald Pool	69.3	156.74
Cliff Spring	91.1	195.98
Black Sand Pool	93.0	199.4
Punch Bowl	94.5	202.1
Comet	94.8	202.64
Splendid	93.6	200.48
Daisy (just before erupting)	94.0	200.1
Daisy (just after eruption)	91.0	195.8
HEART LAKE		
Rustic Geyser (pool)	84.0	183.2
Small geyser 45 ft. NE of Rustic - in hole	94.0	201.2
Largest pool in area	88.0	190.4
SHOSHONE GEYSER BASIN		
Union Geyser, three cones, all boiling:		
" " Eastern Cone	93.0	199.4
" " Central Cone	93.5	200.3
" " Western Cone	93.0	199.4
Minute Geyser	92.5	198.5
Union Geyser area:		
Clear blue circular pool, 68 yds. NE of UG	94.8	202.64
STEAMBOAT POINT YELLOWSTONE LAKE		
Area 100 yds. to south:		
Roaring vent escaping from rock	103.0	217.4
YELLOWSTONE RIVER ROAD		
Mud Volcano	84.0	183.2
Dragon's Mouth	75.0	167.0
CALCITE SPRINGS		
Steam vent 25 ft. down the river	94.0	201.2
Boiling springs near river's edge	94.3	201.74
Spring higher up on slope	72.0	197.6
NYMPH SPRINGS	51.1	123.98

TABLE OF BOILING POINTS OF PURE WATER, ETC.

By Dr. Arthur L. Day; Dr. E. T. Allen,
Geophysical Laboratory, Carnegie Institution of Washington, D. C.

Table of boiling points of pure water at elevations of 6000 to 8000 feet above mean sea level. At mean sea level the boiling points are 212 degrees Fahrenheit (F) or 100 degrees Centigrade (C)

and

Notes on effects of dissolved salts and gas on boiling points; and superheated water and steam; and the source of the heat in the Yellowstone National Park Thermal Waters.

From data supplied the Yellowstone Park Museum, February 17, 1926, by Drs. A. L. Day and E. T. Allen of the Geophysical Laboratory, Carnegie Institution of Washington, D. C.

* * * * * * * * * * * * * * * * *

At elevations between 6,000 and 8,000 feet the average readings of the barometer lie between about 23.5 and 21.5 inches or in round numbers 600 millimeters and 545 millimeters. The following short table gives the boiling points for pure water for pressures within this range:

Approx. Elevation	Average Bar. Pressure		Temperature	
feet	inches	mms.	Fahrenheit -	Centigrade
8,000	21.52	546.3	195.8	91.0
7,600	21.92	556.7	196.6	91.5
7,200	22.34	567.2	197.6	92.0
6,800	22.76	577.9	198.4	92.5
6,400	23.18	588.8	199.4	93.0
6,000	23.62	599.9	200.3	93.5

The boiling points of several springs are slightly raised by the presence of dissolved salts and are lowered by the presence of gas. The sum of the two corrections if usually negative and sometimes amounts to several degrees Fahrenheit. On the other hand, certain alkaline waters in the park are subject to a phenomenon known as superheating which means that steam and water are not in equilibrium as they are in true boiling and as they would be if the waters could be very vigorously stirred thruout. The ultimate cause of this deserves further investigation but the fact that there is little gas in such springs, the escape of which would stir up the water, is probably the immediate cause of the superheating.

Natural steam vents or fumeroles give out steam which is sometimes saturated and sometimes superheated. Superheated steam, it will be remembered, has a lower pressure than saturated steam at the same temperature and cannot be in equilibrium with the water, as the steam in the boiler is. Steam rising from [illegible]ous solution of any kind is superheated. The magma or molten liquid fro[illegible] crystallize is charged with steam and other gases and is a complex [illegible] Steam rising from such a fluid would necessarily be superheated, [illegible]s out theory that the hot springs of the Yellowstone National Park are [illegible]aters heated by steam of such origin.

WATER ANALYSES OF APOLLINARIS SPRING, DEDOLPH SPRING AND IRON SPRING - (GIBBON CANYON)

By Bureau of Chemistry, Dept. of Agriculture (1906)
and
MEDICINAL REPORT ON THE CONSTITUENTS FOUND
By Richard R. Brady, M. D.
(May 5, 1927)

Parts per million parts of water by weight

APPOLINARIS SPRING

0.01	Sodium nitrite;- Too small a quantity to have ann effect.
9.93	Potassium chloride;- Valuable as local antiseptic in throat and mouth diseases, also helpful in chronic dysentery, and in hemorrhoids, increases urinary output.
2.92	Sodium chloride; Very similar in action to Potassium chloride - table salt.
10.66	Sodium sulphate;- Commonly called Glauber's salts. Action is very similar to madnesium sulphate or Epsom salts. Saline cathartic producing watery stools. More severe than Epsom salts and more nauseous in taste. Very mild in this dilution.
31.44	Magnesium bicarbonate;- Antacid and mild laxative. Useful in diarrhea, headache, gastritis or constipation.
24.75	Sodium bicarbonate;- Antacid and chiefly valuable in heartburn, diarrhea and gastric distresses. - Commonly called Soda.
97.65	Calcium bicarbonate;- Also an antacid and a very mild astringent. Useful in gastric disturbances and similar in action to the Sodium bicarbonate. Commonly called chalk.
1.97	Iron bicarbonate;- Useful as a tonic in anaemia and general debility. Less astringent in its action than most of the other iron salts.
8.98	Iron oxide;- Commonly known as rust. Useful in solution as a tonic and an astringent. Caution should be used in taking it in large quantities as it may cause gastro-intestinal distress and constipation.
66.42	Silica;- non-metallic substance - no value - sometimes called sand. Summary - See analysis.

DEDOLPH SPRING

93.95	Potassium chloride;- Same as above, except in larger quantities.
181.90	Sodium chloride;- Same as above, except in very much larger quantities.
220.04	Sodium sulphate;- Same as above except in very much larger quantities.
327.77	Magnesium sulphate;- Commonly known as Epsom salts. Saline cathartic producing watery stools by its osmotic effect. Also used externally to draw fluids to the surface because of this osmotic effect.
391.96	Calcium sulphate;- Commonly called Plaster of Paris. Never used internally as medicine.
11112.54	Calcium bicarbonate;- Same as above except in very much larger quantities.
33.84	Iron bicarbonate;- Same as above except in larger quantities.
78.20	Silica;- Same as above.
	Summary;- See analysis, except that this water should be used sparingly except under a physicians orders.

IRON SPRING, GIBBON CANYON

2.1	Ammonium chloride;- Expectorant. Used chiefly in cough mixtures and lozenges for sore throat or bronchitis.
9.0	Potassium chloride;- Same as above.
39.8	Sodium Sulphate;- Same as above.
15.6	Potassium sulphate;- Very irritant purgative and never used medicinally. At this dilution its action would only be noticed on drinking very large quantities.

WATER ANALYSES OF APOLLINARIS SPRING, DEDOLPH SPRING AND IRON SPRING (GIBBON CANYON).

Bureau of Chemistry, Dept. of Agriculture and Richard R. Brady, M. D.

(Continued)

3.4	Sodium nitrate;- Commonly known as "Chili saltpetre". It is no way similar to potassium nitrate, or common saltpeter, or nitre. Never used medicinally.
14.5	Sodium bicarbonate;- Same as above.
13.8	Magnesium bicarbonate;- Same as above.
22.3	Calcium bicarbonate;- Same as above.
23.1	Ferric Oxide;- Same as Iron Oxide above.
15.1	Calcium silicate;- Not useful in medicine.
86.9	Silica;- See above.
1.0	Hydrogen sulphide;- Either the gas or the solution of the gas is used sometimes in chronic lung conditions as a general tonic. Summary;- See analysis, except that the high sulphur content of this water would be of value when used externally in some types of skin conditions.

* *

PRECISE ELEVATIONS *** YELLOWSTONE NATIONAL PARK

Determined by the U. S. Coast and Geodetic Survey in 1923.

Place of Marker (Concrete Post unless otherwise specified)	Elev. in feet
NORTHERN ENTRANCE - Concrete post at ranger station.	5313
MONTANA-WYOMING STATE LINE - 50 ft. east of highway	5631
POST OFFICE - MAMMOTH HOT SPRINGS	6238
MAMMOTH-GOLDEN GATE ROAD - 2½ miles from Mammoth	7017
GOLDEN GATE - 3 ft. above road 100 ft. so. at Rustic Fall	7255
SEVEN-MILE BRIDGE - 75 ft. north of Gardiner River, and 10 ft. from road	7289
APOLLINARIS SPRING - 15 ft. from road 100 ft. n.w. of spring	7336
OBSIDIAN CLIFF - east side of road in top of boulder	7382
OBSIDIAN CREEK - 150 ft. east of sign	7450
ROARING MOUNTAIN - 20 ft. east of road	7574
FRYING PAN SPRING - 150 ft. south of spring	7519
NORRIS JUNCTION	7483
NORRIS GEYSER BASIN - at south end of boardwalk	7550
GIBBON RIVER RAPIDS - 2¾ miles south of NJ - boulder	7433
GIBBON MEADOWS - opposite cliff 4½ miles south of NJ (stone)	7334
BERYL SPRING	7311
GIBBON RIVER BRIDGE - 6-2/3 miles from MJ (retaining wall)	7184
GIBBON FALL - 2 ft. from stone wall at summit of hill	7133
GIBBON RIVER BRIDGE - 3½ miles east of MJ (steel bridge)	6926
ROAD - 1-2/3 miles east of MJ - boulder 20 ft. south	6862
MADISON JUNCTION - at northeast corner of triangular plot	6804
WESTERN ENTRANCE - 1-6/10 miles east of WE - in boulder	6688
ROAD - 3-7/8 miles east of WE - in rock 15 ft. from center	6705
ROAD - 5¾ miles east of WE - in top of boulder	6734
ROAD - 6¼ miles from MJ - in top of boulder	6752
ROAD - 4 miles from MJ - in top of flat rock 12 ft. from	6760
ROAD - 2 miles west MJ - in top of flat boulder	6788
MADISON-OLD FAITHFUL ROAD - 2-1/10 mi. so. of MJ in rock	7102
ROAD - 4 miles from MJ	7153
NEZ PERCE CREEK BRIDGE	7175
MAMMOTH PAINT POTS - 60 ft. west of	7316
BRIDGE - (Firehole River) - 4¾ miles from Old Faithful	7236
ROAD - 2 miles from Old Faithful	7337
OLD FAITHFUL GEYSER	7365
KEPLER CASCADE	7582
SPRING CREEK CANYON - 4 miles from OF - in boulder	7672

PRECISE ELEVATIONS *** YELLOWSTONE NATIONAL PARK
U. S. Coast and Geodetic Survey - 1923

(Continued)

Place of Marker (Concrete post unless otherwise specified)	Elev. in feet.
ROAD - 6 miles from OF - in boulder	7919
ROAD - 7 miles from OF in boulder	7978
CONTINENTAL DIVIDE - 8½ miles from OF	8261
HERON CREEK BRIDGE	7997
ROAD - 7¼ miles from West Thumb - in boulder	8089
ROAD - 4¾ miles west of WT ranger station - in boulder	8320
CONTINENTAL DIVIDE - second crossing	8364
ROAD - 2½ miles west of WT - in large rock	8227
WEST THUMB JUNCTION - 150 ft. n. e. of ranger station	7782
SOUTHERN ENTRANCE - ¼ mile north - top of rock 60 yds. east	6882
ROAD - 2 miles from SE - in large stone	7152
ROAD - 4¼ miles from SE - in rock	7565
ROAD - 5-7/8 miles from SE - in top of boulder	7858
ROAD - 7-7/8 miles from SE - in large boulder	7763
ROAD - 10 miles from SE - in gray boulder	7741
ROAD - 11½ miles from SE - in boulder - 40 ft. south	7805
LEWIS LAKE - 7-3/8 miles south of WT - rock west of road	7786
ROAD - 7½ miles south of WT - in rock	7802
ROAD - 4-7/8 miles south of WT - in top of rock	7896
ROAD - 3-3/8 miles south of WT - rock 150 ft. south of road	7968
ROAD - 2½ miles south of WT - in rock 50 ft. west of road	7918
CONCRETE CULVERT - 50 yards west of 2nd mile post north of WT	7736
CULVERT - 4½ miles from WT	7737
ROAD - 5-7/8 miles from WT - boulder 16 ft. west of road	7860
ROAD - 8¼ miles from WT - in rock	8428
ROAD - 6-7/8 miles s.w. of LJ - in top of rock	8041
ROAD - 5-1/10 miles s.w. of LJ - horizontal rock ledge	7842
YELLOWSTONE LAKE - 4 ft. above water level - 6 ft. below road	7734
CONCRETE CULVERT - 2-1/8 miles s.w. of LJ	7745
LAKE HOTEL - 35 ft. above the Lake - 45 ft. south of road	7761
LAKE CAMP - 150 ft. east of camp - 1¼ miles south of LJ	7760
LAKE JUNCTION - in triangular plot	7791
EASTERN ENTRANCE - 60 ft. north of ranger station 300 ft. west of entrance	6950
ROAD - 1½ miles from entrance - disc vertical in boulder	7083
ROAD - 4¼ miles from entrance - disc vertical 40 ft. east	7485
ROAD - 5½ miles from entrance - in large boulder	7778
WALL OF TUNNEL - in s.e. wing-wall - 6-2/3 miles from EE	8161
SYLVAN PASS (As determined by the National Park Service) (by civil engineer W. I. Davis)	8559
SYLVAN LAKE - 30 ft. from Lake - 60 ft. so. - 4 ft. higher	8413
ROAD - 11 miles from EE - in large boulder	8498
ROAD - 12-15/16 miles from EE - 57 yards no of road - boulder	8471
ROAD - 15½ miles from EE in boulder	8445
ROAD - 10 miles from LJ - in boulder	8123
ROAD - 7¾ miles from LJ - in boulder	7965
ROAD - 6 miles from LJ	7995
ROAD - 3-2/3 miles from LJ - 20 yards from Squaw Lake	7792
ROAD - 2 miles from LJ - 180 ft. east of Pelican Creek	7739
ROAD - 2 miles north of LJ - in top of stone	7759
ROAD - 3-3/8 miles north of LJ - in top of stone 200 ft. west of water station	7717
MUD VOLCANO - 6¼ miles from LJ - 15 ft. from edge of road	7749
ROAD - 7 miles s.e. of Canyon Junction - concrete bridge	7686
ROAD - 6½ miles s.e. of CJ - in n.w. corner of concrete bridge over Trout Creek	7684
ROAD - 5 miles s.e. of CJ - 45 ft. west of road center	7737
ROAD - 2¾ miles south of CJ - top of large boulder	7686
CANYON JUNCTION - 30 ft. south of road center - top of cut	7733
CANYON-NORRIS ROAD - 2 miles west of CJ - small rock	8121
GRAND CANYON - 10 ft. from Canyon at jnctn of Insp. Point road	7799
ROAD - 2½ miles north of CJ - boulder west of road	8014

PRECISE ELEVATIONS *** YELLOWSTONE NATIONAL PARK
U. S. Coast and Geodetic Survey - 1923

ROAD - 4-9/10 miles north of CJ - rock ledge west of road	8549
DUNRAVEN PASS - jctn of road to summit of Mt. Washburn	8859
ROAD - 9-1/8 miles from CJ - set in vertical wall of rock	8855
MT. WASHBURN - (as determined by National Park Service - civil engineer W. I. Davis)	10317
ROAD JUNCTION - where Washburn road re-enters 9 miles south of Tower Junction	8751
ROAD - 7¼ miles south of TJ - boulder 6 ft. above road	8017
ROAD - 5-1/8 miles south of TJ, boulder 15 ft. west of road	7326
TOWER FALL PUBLIC AUTO CAMP - 15 ft. south of road and 200 feet south of Haynes Shop - where TF trail enters - top boulder	6597
ROAD - 2-1/10 miles s.e. of TJ - in cliff at west of	6509
TOWER JUNCTION - 20 ft. east of road intersection	6264
ROAD - 2½ miles west of TJ - rock at edge (south) of cut	7000
ROAD - ¼ mile north of Crescent Hill - rock west of road	7571
ROAD - 6½ miles n.w. of TJ - large flat rock north of road	7190
ROAD - 8½ miles east of MSJ, flat boulder 35 ft. so. of road	6791
ROAD - 5-7/8 miles east of MSJ, granite boulder south og	6630
ROAD - 4-1/3 miles east of MSJ, top of stone parapet support	6669
GARDINER RIVER STEEL TRESTLE - 1-6/10 miles east of MSJ in west abutment	5961
POST OFFICE - MAMMOTH HOT SPRINGS	6238

ANIMALS OF YELLOWSTONE NATIONAL PARK
LISTING NAMES GIVEN THE MALES, FEMALES AND YOUNG.

By Ranger Marguerite Lindsley

Approved by:
Dr. William T. Hornaday, New York State Zoological Park, (Symbol "H")
Dr. Joseph Grinnell, University of California, (Symbol "G").

ANIMAL	MALE	FEMALE	YOUNG
Antelope	buck	doe	kid
pronghorn			
Badger			
Bat			
Bear	boar H	sow H	cub
Beaver			
Bison	bull	cow	calf
buffalo			
Bobcat	tom G		cub H
			kitten G
Buffalo	bull	cow	calf
bison			
Catamount	tom H	lioness G	cub H
	lion G		kitten G
cougar			
mountain lion			
painter			
panther			
puma			
Chipmunk			
Cony			
pika			
rock rabbit			
Cougar	tom H	lioness G	cub H
	lion G		kitten G
catamount			
mountain lion			
painter			
panther			
puma			
Coyote	dog H&G	bitch H&G	cub
			pup H&G
prairie wolf			
Deer	buck	doe	fawn
Elk	bull	cow	calf
wapiti			
Ermine			
weasel			
Fish			minnow-fry G
Fox	dog	bitch H	cub H
		vixen G	pup G
Gopher			
ground squirrel			
picket pin			
Ground Hog			
marmot			
woodchuck			
Ground squirrel			
gopher			
picket pin			
Lynx	tom G		kitten H&G
Marmot			
ground hog			
woodchuck			
Marten			
Mink			
Moose	bull	cow	calf

ANIMALS OF YELLOWSTONE NATIONAL PARK
LISTING NAMES GIVEN THE MALES, FEMALES AND YOUNG — Lindsley

ANIMAL	MALE	FEMALE	YOUNG
Mountain lion	tom H lion G	lioness G	cub H kitten G
catamount			
cougar			
painter			
panther			
puma			
Mountain Sheep,	ram	ewe	lamb
Mountain rat			
pack rat			
Muskrat			
Otter			pup or kitten G
Pack Rat			
mountain rat			
Painter	tom H lion G	lioness G	cub H kitten G
catamount			
cougar			
mountain lion			
panther			
puma			
Panther	tom H lion G	lioness G	cub H kitten G
catamount			
cougar			
mountain lion			
painter			
puma			
Picket Pin			
gopher			
ground squirrel			
Pika			
cony			
rock rabbit			
Pole Cat			kittens
skunk			
Porcupine			
Prairie Wolf	dog G	bitch G	cub or pup H pup G
coyote			
Pronghorn	buck	doe	kid
antelope			
Puma	tom H lion G	lioness G	cub H kitten G
catamount			
cougar			
mountain lion			
painter			
panther			
Rabbit			kitten H
Rock Rabbit			
cony			
pika			
Skunk			kitten
pole cat			
Squirrel			
Wapiti	bull	cow	calf
elk			
Weasel			
ermine			
Wolf	dog G	bitch G	pup G
Wolverine			
Woodchuck			
ground hog			
marmot			

ANIMALS OF YELLOWSTONE NATIONAL PARK
LISTING NAMES GIVEN THE MALES, FEMALES AND YOUNG — Lindsley

Footnote:

This alphabetical, partial list of the animals showing some of the synonyms was compiled first with the aid of Websters Standard Dictionary and copies were sent to Drs. Wm. T. Hornaday and Joseph Grinnell for their corrections and suggestions. Quotations were placed there by those men and their initials follow each correction or addition made by them. Where they differed both authorities are given. Dr. Hornaday gives as his final authority the century Dictionary.

* * * * * * * * * * * * * * * * * *

ANIMALS OF YELLOWSTONE NATIONAL PARK
LISTING SINGULAR AND PLURAL FORMS OF NAMES.

By Ranger Marguerite Lindsley

Approved by Dr. William T. Hornaday, New York State Zoological Park,
Dr. Joseph Grinnell, University of California.

SINGULAR SINGULAR One individual One species	PLURAL PLURAL (INDIVIDUALS) Two or more individuals of one species.	PLURAL PLURAL One or more individuals each of two or more species.
Antelope	antelopes	antelopes
Badger	badgers	badgers
Bat	bats	bats
Bear	bears	bears
Beaver	beaver	beavers
Bison	bison	bisons
Bobcat	bobcats	bobcats
Buffalo	buffaloes	buffaloes
Catamount	catamounts	catamounts
Chipmunk	chipmunks	chipmunks
Cony	conies	conies
Cougar	cougars	cougars
Coyote	coyotes	coyotes
Deer	deer	deers
Elk	elk	elks
Ermine	ermines	ermines
Fish	fish	fishes
Fox	foxes	foxes
Gopher	gophers	gophers
Ground hog	ground hogs	ground hogs
Ground squirrel	ground squirrels	ground squirrels
Lynx	lynxes	lynxes
Marmot	marmots	marmots
Marten	marten	martens
Mink	mink	minks
Moose	moose	mooses
Mountain lion	mountain lions	mountain lions
Mountain sheep	mountain sheep	mountain sheep
Mountain rat	mountain rats	mountain rats
Muskrat	muskrats	muskrats
Otter	otters	otters
Pack rat	pack rats	pack rats
Painter	painters	painters
Panther	panthers	panthers
Picket pin	picket pins	picket pins
Pika	pikas	pikas
Pole cat	pole cats	pole cats
Porcupine	porcupines	porcupines
Prairie wolf	prairie wolves	prairie wolves
Pronghorn	pronghorns	pronghorns
Puma	pumas	pumas

ANIMALS OF YELLOWSTONE NATIONAL PARK
LISTING SINGULAR AND PLURAL FORMS OF NAMES — Lindsley

Rabbit	rabbits	rabbits
Rock Rabbit	rock rabbits	rock rabbits
Skunk	skunks	skunks
Squirrel	squirrels	squirrels
Wapiti	wapiti	wapitis
Weasel	weasels	weasels
Wolf	wolves	wolves
Wolverine	wolverines	wolverines
Woodchuck	woodchucks	woodchucks

* *

ANTLERED OR OTHERWISE HORNED ANIMALS OF YELLOWSTONE PARK

ELK DEER MOOSE MOUNTAIN SHEEP BUFFALO ANTELOPE

Compiled by Ranger Marguerite Lindsley

Approved by:
Dr. Wm. T. Hornaday, New York State Zoological Park, New York,
Dr. Joseph Grinnell, University of California, Berkeley, California,
Superintendent Horace M. Albright,
Mr. E. J. Sawyer, Yellowstone Park Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

Horns: (Webster) "The processes borne on the heads of many ungulates (hoofed mammals) and used chiefly as weapons of offense or defense. The term includes structures of several distinct kinds, sometimes median in position, but usually lateral and paired. Those of cattle, sheep, goats and true antelopes are unbranched and permanent and usually present in both sexes. They consist in a bony sheath of epidermal substance (tough, fibrous material of which true horns are composed) supported by a bony core. Those of deer, specifically called antlers, are solid, bony, usually branching outgrowths, which are shed annually, and are present usually only in the male. Those of the pronghorn are in some respects intermediate between the above types. - "

Antlers: (Webster) "The entire horn, or any branch of the horn, of an animal of the deer family. Antlers differ from the horns of other ruminants (hoofed animals which chew the cud) in being solid, generally branched, bony outgrowths, shed and renewed annually. Usually they are present only in the male, but also in the female of the reindeer and caribou. When growing they are soft and covered with a downy, vascular covering, the velvet, which afterwards wears or is rubbed off. The main stem is called the beam; the branches, the tines or points. The latter are generally more numerous in older animals, horns of young bucks being simple spikes. - - "

Pronghorn: (Webster) "A peculiar ruminant confined to the treeless parts of the western United States and Mexico. It is not a true antelope, but the sole representative of a distinct family (Antilocapridae). The coloris chiefly a yellowish tawny above and white below, with a white rump patch and a tawny collar. The horns, which are present in both sexes, and furnished with a single, anterior prong, are hollow and set on a bony core as in the oxen, etc., but are shed annually, as in the deer. It is now much reduced in numbers.

It is interesting to note that the true horns are spoken of as a "horny sheath of epidermal substance, supported by a bony core" and are comparable to the fingernails or to the hair or hoofs, processes of the skin. And on the other hand we have the antlers which are composed of bone and are processes of the skeleton.

In Yellowstone National Park the horns of the mountain sheep and of the buffaloes are the only true horns. Those of the elk, deer, and moose are true antlers. Those of the pronghorns, or antelopes as they are called, are the intermediate ones described by Webster in the above. The pronghorn is the only hoofed animal in the world that ever sheds its horn-sheath.

ANTLERED OR OTHERWISE HORNED ANIMALS OF YELLOWSTONE PARK — Lindsley

The antlered animals, elk, deer and moose, shed their horns in the very early spring or late winter, in February or March usually, and immediately thereafter the new ones start to grow. During the time that the horns are growing they are soft and spongy and are covered with a thick layer of skin, and the whole structure is richly supplied with blood vessels and nerves. The blood is the building agent and the nerves keep the growing horns very tender, so that the animal will not use them nor even touch them against anything hard if he can avoid it. Thus they are carefully protected against injury while they are still soft. The horns are fully grown in late August or September but the protecting skin does not fry up and start to peel off until the last month of September. Then the animals rub them against trees and bushes, stripping off the dead skin and leaving the new, sharp antler, fully grown, ready for the fighting season.

All American horned animals have hoofs, but all hoofed animals do not have horns. We immediately think of the horse and the pig. All of the native hoofed animals in Yellowstone National Park are ruminants, chewing the cud.

* * * * * * * * * * * * * * * * * *

CENSUS OF THE WILD ANIMALS OF YELLOWSTONE NATIONAL PARK

By Sam T. Woodring, Chief Ranger

March 1, 1927

Buffalo, Lamar Valley Herd		Full count	819
Buffalo, Cold Creek-Pelican Flats Herd		Estimated	125
Actual counts this season 62			
		Total	944
Mountain Sheep		Count	346
Antelope		Count	641
Moose		Estimated	525
Deer, Mule		Estimated	1725
Deer, White Tail		Estimated	12
Elk	February 1927	Count	17347
Black Bear		Estimated	200
Grizzly Bear		Estimated	75

These figures vary somewhat from the counts submitted previously, particularly with reference to the antelope, deer, elk and buffalo; the antelope figure is based on actual counts.. The other variances result from taking into account the losses that have occurred during the fall and winter months; these losses include kills by hunters outside the park, winter kills, predatory animal kills, and death resulting from accidental injuries. All shipments have likewise been deducted from the herd totals.

PREDATORY ANIMALS OF YELLOWSTONE NATIONAL PARK

Compiled by Ranger Marguerite Lindsley

Approved by:
Superintend nt H. M. Albright,
J. E. Haynes, Acting Director of the Museum,
E. J. Sawyer, Yellowstone Park Naturalist,
Sam T. Woodring, Chief Ranger,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Dr. F. E. A. Thone and Mr. M. P. Skinner.

Predatory or Predacious; (Webster) "living by preying upon other animals".

In Yellowstone National Park, the largest wild animal sanctuary in the United States, the subject of predatory animals is of considerable importance, in that only predatory animals are destroyed by authority of the Federal Government, and then only by the Government employees.

More and more frequently is being raised the question as to the advisability of killing off all of the predatory animals of any one species in a game preserve. It is thot by some that this would do harm by so disturbing the equilibrium of nature that some undesirable condition might result. All animals, strictly predacious according to the definition, are not being destroyed here in Yellowstone Park. Those shot here are the coyote or prairie wolf, the timber wolf or lobo as he is sometimes called, and the mountain lion, known also as the cougar, puma, panther, catamount, or painter.

The policy of the National Park Service is not to exterminate predatory animals or birds. The animals that do the most damage are to be reduced, particularly in the areas where they are likely to do the greatest harm. For instance, the rangers concentrate on the killing of coyotes in the northern part of the park because they are so destructive to young antelope and that is their range.

The larger mammals here are the deer, elk, antelopes, mountain sheep, moose and buffaloes. The last two are especially well able to protect themselves and their young, and it is only when an individual is not as healthy as he should be, or when the young ones become separated from their mothers, or the individual is injured, that there is danger for them from the larger predatory animals.

Of the rodents or gnawing mammals, we have in the park, more representatives than of any other group. They are represented by the following: ground squirrel, marmot, chipmunk, mouse, pack-rat, cony, rabbit, muskrat, porcupine and squirrel. Most of these are represented by more than one species; for instance, under the heading of rabbits we find jack rabbits, snow-shoe rabbits, and cotton tails.

In further discussing predaciousness in the park let us first consider the birds. The bald eagle, the National Bird, is disappointing in much the same way that the lion is disappointing as the "king of beasts". The lion is a coward and the bald eagle is a carrion eater,- a meat eater that kills very little of his own food, and a robber, having been known to steal fish caught by the osprey. The golden eagle, however, is a permanent and not an uncommon resident in the park. This species usually kills its own prey and is therefore, of more noble standing than the ill-chosen national emblem.

The fact that the mountain sheep do not increase any more rapidly in the park has been attributed to the activity of both species of the eagles. Careful observers are of the opinion that a large number of young sheep and young antelopes are killed annually by eagles. The mother deer carefully protects its young from predatory enemies, but antelopes and sheep leave them "under cover" for hours at a time, and upon being exposed to view, as they often are, they become the easy prey of predatory animals or birds.

As to the hawks. First we have the osprey, or fish hawk, which lives almost entirely on fish which he usually catches alive in the streams or lakes. There are other hawks in the park whose prey consists of rodents, insects, reptiles and small birds. There are also owls, whose diet is much the same as that of the hawks, consisting chiefly of rodents, birds, reptiles, insects, frogs and toads.

PREDATORY ANIMALS OF YELLOWSTONE NATIONAL PARK Lindsley

Among the fish-eating birds besides the osprey, we find of foremost importance the pelican, that well known glutton which eats daily a large number of fish; then the merganser, or fish duck, and several other species of ducks, found on park waters are large consumers of fish. Finally we come to the great blue heron and the belted kingfisher, the former living to a great extent, the latter almost entirely, on fish.

Now we will take up the predatory mammals. First and best known is the coyote which lives almost entirely on rodents,- gophers, mice, chipmunks, rabbits and all, but which will always kill one of the larger mammals if the opportunity presents itself in the form of a straggling, sickly calf elk, deer fawn, young antelope, or even a calf buffalo. In the winter each buffalo herd has a following of coyotes, two or three of them always within sight and often very near, watching for the sick or disabled, or the old timer to go off by himself to die; these are the coyotes'feast. In the same family are the fox and the wolf, the former smaller than the coyote and not so clever, the latter larger and with much greater strength. These two are both nearly all gone from the park now and are very seldom seen by the winter rangers.

As to the cats; these are, first, the mountain lion, catamount, cougar, puma, panther, painter, as you wish to call him, and the lynx, the bay-lynx or bobcat. Both of these animals are fond of any fresh meat but perhaps are not so vicious as they are often pictured. They are extremely curious and very stealthy and stories of their following people are quite probable. As to the fact of their being able to leap great distances through the air, there is no question about it. "Agile as a cat" is a phrase based on a fact. The mountain lion ordinarily kills all but the largest of the larger mammals, and also rodents and a few birds. The lynx is not far behind in prowess tho much smaller in size, but lives primarily upon the snow-shoe rabbits of the wooded districts. These animals also are nearly all gone from the park. The very fine mounted specimen of a mountain lion in the Museum is an animal which was caught in the winter of 1924-5 by Chief Ranger Woodring and others.

The badger is a small animal, not much larger than a good sized marmot, and he is extremely bloodthirsty, living most of the time on gophers, marmots and other small rodents. The weasel, or ermine as he is in the winter, and the marten or pine marten, are both carniverous little animals that live on small mammals and birds.

The skunk or "polecat" is another meat eater, living on young rodents, frogs, insects and an occasional bird.

The otter and mink are both aquatic, the former much more so than the latter, and are oftenest found along some stream, fishing. The otter lives almost entirely on fish but the mink eats many small animals and birds. Both the otter and the mink have a lust for killing far in excess of their needs. They fish largely in the smaller streams as there the fish have less chance of escape than they do in the larger rivers.

Of the bears, the grizzlies are more apt to be killers than the blacks (including the browns and cinnamons) but none of them do much in that line in the park, being naturally lazy and not at all particular about their food. They are undoubtedly happiest when they are eating and they will eat anything and everything in sight at any time. None of the bears are considered predacious.

The only large snake found in the park is the bull-snake, a big snake marked quite a bit like a rattler (of which there are none in the park), not only entirely harmless to man, but really a beneficial snake, altho predacious in the strictest sense of the word. The bull-snake lives on small rodents, frogs, insects and other snakes.

This concludes a preliminary discussion of the birds and animals or prey as they are found in Yellowstone National Park.

YELLOWSTONE PARK BEARS

The lecture given at Grand Canyon Hotel during the season of 1926,
by Temporary Park Ranger Elmer A. Kell Jr.

Approved by:
Superintendent H. M. Albright,
Park Naturalist E. J. Sawyer,
Dr. H. S. Conard, in charge of the Ranger Naturalists,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

One of the many duties of the National Park Service, the guardians of the National Parks and Monuments of this nation, is the "interpretation of the Park's wonders". For this purpose a Ranger Naturalist Service was organized whose duty it is to guide the people around the more interesting points during the day and to deliver leactures at the various hotels and camps in the evening. The Service is attempting to put before the visitors the important and interesting explanations of the different phenomena, the wild animal life, and a history of the Park, in terms which are readily understood by the average visitor. In this connection a short lecture has been arranged at Canyon on the bears, one of the most interesting studies in the Park.

The first thing that I wish to explain is that there are only two types of bears in Yellowstone instead of three as many people believe. They are the grizzly and the American Black Bear. Many people put the brown and cinnamon bear in a separate class, but they are all members of the black bear family -"blondes and brunettes", so to speak.

In the early days of the Park hunting was allowed, and, as a result the bears never reached very great numbers. But in 1886 when the military took over the Administration of this playground all hunting was stopped. The bears soon learned that man meant no injury, and that they were safe within the park limits. I do not mean to have you believe that the bears know where the boundary line is, and that they walk up and down just inside, laughing at the hunters who are waiting for them to step over. That is too much of a bear story, like some of the fish stories our friends tell us. But many bears do wander outside each winter and are never heard of any more.

By 1889 black bears were to be seen on the different garbage dumps in small numbers. They came at night and were very shy and timid. In 1890 they became so numerous and troublesome that the Administration considered getting rid of them, but the tourists made kno n their interest in these animals so that it was decided to allow them to remain in their native haunts. On April 5th of this year, Chief Ranger Woodring, in an official report to the Director of the Museum, estimated that there were 200 black and 75 grizzlies in the Park.

Another misconception in the minds of many persons who are acquainted with the facts is the idea that all grizzlies are bloodthirsty, savage killers, attacking man or beast for no reason whatsoever. This is far from the true state of affairs as the grizzly has been found to be the more trustworthy of the two. The black bear is a big bluffer. The only trouble is that his bluff charge is liable to turn into a real charge at any instant. But with this characteristic trait of treachery, they also carry one of great curiosity. They are always investigating new and strange things, especially the automobiles and camps of the tourists. Many tales are told of funny experiences that these people have with the bear thieves.

They especially like ham, bacon and sweets. Several years ago, a tourist at Norris tied what happened to be the major portion of his morrow's breakfast, a small slab of bacon, to a rope which he slung over a limb extending above his tent. A bear sauntering by that night on his customary nocturnal quest for food caught a whiff of that savory morsel. He climbed the tree and slipped out onto the branch over which the rope was slung. He was thinking more of the food than of the strength of the limb. It snapped, tumbling the bear onto the tent. The tourist was terrified and with a loud voice awakened everyone in camp. The bear was in as much hurry to leave as the tourist was to have him leave. In his hurried exit he scattered the furnishings of the tent in all directions making a nice mess of the camp. The tourist swore up and down that he had been attacked by a grizzly. He did not know that a grizzly cannot climb trees.

YELLOWSTONE PARK BEARS Kell

Before taking up the life and habits of the bears, I wish to bring up a subject which causes us a great deal of trouble each year. I refer to the feeding of bears by park visitors. Many people do not feed them, but make them do tricks to get the food. This is considered molesting and teasing and is discouraged by the Park officials. It has often resulted disastrously for the person doing the feeding. I have just pointed out the treacherous trait in the black bear family, so I think that you can readily see that it is much safer to leave them alone. There is plenty of food to feed many more bears than there are in the Park at present so they will not miss the small morsel that you could give them.

Every hotel and camp has its bear dump where the visitor can see the bears in perfect safety. A ranger is on duty at each dump to watch the bears and answer any questions that you may wish to ask him. I would also like to bring to your attention the fact that noise will scare the bears away. Many people come out to see the show on the bear dump and when they are satisfied and ready to leave they are usually rather noisy in getting their party together. They never think that the noise they are making will spoil the show for someone else. I would also ask you to refrain from waving handkerchiefs when on the dump as that also will scare them. And so I wish to make two pleas to you and your friends. The first is to leave the bears alone, and the second to refrain from noisy actions when approaching, leaving, or present at a bear dump.

And while we are on the question of feeding I shall take up the various foods that they live on. If one was to compile a list he would have to put down almost everything edible. The main source of food during the summer months is the garbage dumps of the hotels and camps scattered through the park, bear dumps as they are called in the Yellowstone lingo. Another source of food supply is the smaller animals such as mice, woodchucks, ground squirrels and chipmunks. When driven by extreme hunger a bear will attack a full grown elk or deer, but these cases are rare as there is too much food to be gotten in an easier manner.

When a bear does start to feed he hogs everything for himself. They seldom carry anything away. If a black bear decides to seek a better place to dine, he usually goes only a short way into a dense thicket which will hide him from the sight of others. The grizzly is known to hide the carcass of his kill, sometimes, but ordinarily they eat what they wish and leave the rest. Other articles on their menus are herbs, grubs, worms, berries, the soft inner layer of bark, ants, nuts, and fish, especially in Alaska. An Alaska bear will lay for hours on the bank of a small stream with one paw hanging lazily in the water. With a sudden tensing of his muscles and sweep of his paw he will throw a trout from the stream and pounce on it before it can get away.

As I have mentioned before each hotel and camp has its bear dump. No doubt you will be interested to know what species and the approximate number you will meet at you different stopping places.

Mammoth	Small number	Black	
Norris	" "	"	
Madison	" "	"	
Faithful	More numerous	"	with occasional grizzly
Thumb	Few	"	
Canyon	Very numerous	"	and grizzlies common
Lake	" "	"	" " "
Roosevelt	" "	"	

There are also many bears back in the timber which seldom come out on the road or the dumps.

Another interesting thing about a bear is his mode of living. This must be divided into two parts; summer and winter. The summer life can be disposed of in a few short sentences. They have no regular home; a handy tree or thicket serves as their domicile when one is needed. Most of their time is spent in roaming around the vicinity of the garbage dumps or panhandling along the road. The most interesting part of their life to us is that of the winter hibernation. Late in the summer they begin to grow fat and restless, making long trips for the purpose

of finding a place for their winter sleep. It is seldom that a bear will occupy the same den two years in succession unless they can find nothing better. Grizzlies usually select a dry warm place at about 7500 feet altitude. If they cannot find a place ready-made, they will dig a hole in a slope. Blacks also select caves and in addition will hole up in a hollow log or under a heavy windfall. The time that they go into hibernation differs. It is affected by several things, such as climatic and food conditions. The usual time for them to go in is from the tenth to the twentieth of October, although some have been seen out as late as November first or even later. When they begin their sleep they usually have about three inches of long hair as protection against the elements, and four inches of fat which serves as food. When they awake in the spring they look as fat as in the fall, but the fat has become spongy and is of no value. By two weeks after they have made their appearance, they have lost this spongy tissue and have a "lean and hungry look". Around the middle of April is the usual time for them to make their appearance, although they have been seen out as early as the latter part of March.

It is during the winter sleep that the young are born. The mating season is during June and July. They mate for two weeks and then separate probably never to see each other again. The species do not intermate except in very rare cases. The blacks breed every two years; the grizzlies apparently every three. The usual litter is two, but a one or three cub litter is not uncommon. At birth a black bear is about nine inches and a grizzly about twelve. They open their eyes at the end of forty days, and start to walk at about two months. At the end of three months they have grown so that the black weighs about three pounds and the grizzly ten. They are usually weaned at the end of a year. The first winter after their birth they usually sleep with their mother, leaving her the following spring. The litter stays together for a year and hibernate together that winter, scattering to the four winds the next spring or when a little over two years old. The American Black Bear reaches maturity in three years and the grizzlies in eight, although the latter breeds when three and a half years old. At maturity the black weighs from three to four hundred pounds; grizzlies from five to six hundred pounds. Both species have been known to reach even greater weights as they grow older. Last year on the Canyon dump we had several grizzlies that we estimated to be around eight to nine hundred pounds and several that were even larger.

The average American Black bear is a glossy smooth-coated animal with a tan or brown muzzle; short black curved claws, incapable of being withdrawn without tearing; teeth composed of some sharp cutters and broad grinding molars, ... evidence of their two kinds of diet; small erect and almost hidden ears; a short and practically non-existant tail. They ordinarily stand twenty-five inches at the shoulders and about five feet from tip to tip.

The grizzly's coat runs from a silver-tipped fur that is gray for two inches from the tip. Their claws are brown in color, straighter than the blacks and two or three times as long. They also have narrower forcheads and squarer muzzles. Their shoulders stand high giving them the appearance of saddlebacks. There is quite a distinction between the walks of the two types. The grizzly has a shuffling walk that carries an indication of great power, whereas the black looks clumsy and awkward, nevertheless bears of either species will outrun an average gorse and will often travel forty or fifty miles in a day. Another big difference as mentioned before, is that blacks climb trees while grizzlies do not. Grizzly cubs, before their claws begin to straighten can scamper up a tree, but a mature grizzly cannot climb. All bears have very poor eyesight, but this is offset by their keen sense of hearing and smell.

In closing I wish to call your attention to the Museum which is located in the same building as the Information Office at Mammoth. The building is easily located by the pile of elk horns in front. Many interesting exhibits of different things in the Park, such as the wild animal and bird life, ... formations, etc., have been arranged for your enjoyment. Mr. Sawyer, the Park Naturalist, or one of his assistants is on duty at all times, and they will gladly escort you thru, explaining the different exhibits.

I have been able to give only a few general remarks in this short time. One could talk for hours on this subject as each bear is a study in itself. If anyone wishes to ask any ... questions I shall be very glad to answer them if he will see me in the lobby after the program.

REVIEW OF THE BIRD LIFE OF YELLOWSTONE NATIONAL PARK

By Edmund J. Sawyer, Park Naturalist

Approved by:
Superintendent H. M. Albright,
Mr. J. E. Haynes, Acting Director of the Museum.

INTRODUCTION

A remark which one frequently hears from tourists in the park is that birds seem to be scarce in the reservation. That impression of scarcity is rather falacious, tho it does have some foundation. Most of the tourists ceome from sections of the country which are very much more settled. They are unused to bird life conditions in places where wilderness surroundings so vastly predominate. In the settled parts of the country the birds have perforce grown accustomed to highways and to highway conditions of traffic; to cities and villages and everything which is associated with proximity to civilization. That accounts for the fact that in such parts of the country the bird life is more intimate, more familiar; so that the layman from a populous region acquires the impression that birds are inclined to be bold and confiding. The fact is, however, that birds are timid and retiring by nature; and that fact is well shown in such an area as Yellowstone Park where natural conditions prevail. If there are few birds seen on the regular loop tour itself, as compared with the number which should be expected in an equally diversified ride in the country near New York, Philadelphia or Chicago, it is largely because of the wilder places being available all about the park. In other words, the birds prefer wild conditions and in Yellowstone Park such conditions are to be had in abundance; the birds do not have to dwell within the din and dust of traffic.

One Effect of Altitude

There is another condition which affects our bird life in a more fundamental way. The elevation of the Park, - approximately 5000 to 10000 feet, - does not favor maximum bird life, particularly as to the number of species. Lower altitudes, other conditions being equal, are richer in number of species.

The Chief Feature of Yellowstone Bird Life

The bird life of Yellowstone Park is, therefore, not remarkable for number of species or abundance of individuals in general. The most outstanding feature of its bird life as a whole is perhaps the fine representation it contains of species which are typical of the Rocky Mountain region and characteristic of the Hudsonian and the Arctic-Alpine life zones.

Number of Species and Their Availability

The list of known Yellowstone Park birds has been brought to 204 or 205 species, one or two records being somewhat doubtful, but other species will probably be added before the list is finally completed. Many of these are, of course, very rare or even of accidental occurrence. Yet fully half the number may be considered regular and quite common, while sixty or seventy are easily possible for the observing amateur to list in the course of any week of the tourist season. I know of localities where on any fine day of the season from twenty to thirty species may be seen in the course of a two hour walk. For, tho our park bird life is not marked by either abundance of species or density of bird population in general, it is nevertheless true that in many favorable localities there is concentrated a community of birds which, both in diversity of species and number of individuals, might be considered rich in any region.

Diversity of Species

While it must be admitted, and has been admitted, that our avifauna is not distinguished by general abundance, it is just as true that the birds we have show a very remarkable range in classification. Indeed, the range could scarcely be greater; for the utmost extremes are actually represented, - by grebes on the one hand and thrushes on the other. These represent, respectively, the Orders Pygopodes - diving birds - and Passeres - perching birds. All but three of the intervening fifteen orders of North American birds are represented in Yellowstone Park; the omissions being the Tubinares - the tube nosed swimmers -, Odontoglossae - flamingoes -, Psittaci - parrots and parrot-like birds. Thus it is seen that even so pelagic an order as that containing the frigate or man-o'-war-bird is represented; in this case by the white pelican. Of the order of perching birds, every one of the twenty families is represented.

REVIEW OF THE BIRD LIFE OF YELLOWSTONE NATIONAL PARK Sawyer

Residents and Migrants

As to the status of Yellowstone birds when divided according to time of appearance or residence, they show no pronounced general departure from what is general with the bird life of lower and more uniform altitudes. Thus, crows and jays are permanent residents, as are our grouse and certain woodpeckers; our thrushes swallows, flycatchers and humming-birds are summer residents, partly migrants; our grosbeaks, cross-bills and waxwings are rather wandering, local and irregular somewhat as in their eastern range, tho their status is more nearly that of permanent residents in the park. Finally, we have the snow bunting, redpoll, buffle-head duck as winter visitants. However, the thermal springs and streams create conditions which are peculiarly reflected in our bird life in certain cases.

Snipes and Kingfishers as All Winter Birds

It may sound weird to say that one can go out on snow-shoes in the coldest day of January, confident of flushing Wilson snipe or "jack" snipe, as they are called by shooters. Yet, such is the fact; and it illustrates the general weirdness of this park area from an unfamiliar angle; for it is just as much a freak of nature, in the ornithological field, as the geyser or the mud-pot is in the geological domain. The belted kingfisher and the red-shafted flocker are two more permanent resident species which owe this unusual status to the influence of thermal springs and streams. The vegetation along or about these warm water areas is kept green all winter and with this condition is undoubtedly correlated the presence of the usual low forms of life in an active state, so that the snipe and other birds find an abundance of marine and other insects for food, while the kingfisher always finds open water in which to fish. The mallard duck, green winged teal, and perhaps an occasional other species of duck,usually a summer resident in our northern states, are also permanent residents in the park. This is also due to the fact that there is always open water in our warm streams and ponds.

Abundance of Predatory Birds

The Order of Raptores, or birds of prey, is represented in the park by an exceptional abundance of individual birds and quite a range of species. Our form of the eastern "hen hawk" (the larger of the two species commonly so-called) is the Western red-tailed hawk. This species, with one or two others of similar size and general appearance, occurs as a summer resident and predominates among the birds of prey if we make an exception of the little sparrow-hawk whose robbin-like size keeps him out of the limelight and conceals his predatory nature. Now the reason for the great number of hawks of the red-tails type is doubtless to be found in the person of the Kennicott ground squirrel, spermophile or, as it is better known in park phraseology, "picket pin" or "gopher". These little mammals constitute the chief staple of the Red-tail and his congeners, as food for adults and young alike. When it is considered that thousands of these hawks depend on the ground squirrels for perhaps two-thirds of their total summer food supply, it can be better understood why the little picket-pin, - already occuring in hundreds of thousands if not in millions, - does not actually exist to the exclusion of all other animals. However, it must not be thought that the hawks wholly account for Nature's balance in the case of the ground squirrel. The badger, mink and weasel are important factors in keeping the number of picket-pins reduced to even their present teeming multitudes.

Interesting Water-Birds

It may be news to more than one layman, that Yellowstone Park, so high and dry in general, is particularly blessed with water birds. Not only are there exceptional numbers of ducks, geese and waders, but grebes, gulls, terns and pelicans; so that, if one were to view a collection of Yellowstone water-birds on a museum shelf, accompanied by nothing but their conventional wooden stands, he might well think the collection represented some coastal or at least sea-level area. Nothing there would suggest that those birds could have come from an inland and mountainous region. For, the latter general condition is rendered largely null by the myriad streams, lakes, springs, swamps and wet meadows of the park. We cannot by any means here attempt to discuss all the species, or even very many of those which are most interesting; but a few are so exceptional that they cannot well be passed over without brief but particular mention.

REVIEW OF THE BIRD LIFE OF YELLOWSTONE NATIONAL PARK Sawyer

Some Noteworthy Ducks and Geese

Several things combine to make the Barrow goldeneye duck the most noteworthy water-bird in Yellowstone Park. Generally quite rare in the United States even in winter, and spending its summer chiefly in the far north where it breeds, Yellowstone Park contains a goodly share of the high, secluded little lakes which alone constitute its breeding area within Uncle Sam's domains. The goldeneyes are called"whistlers" by sportsmen, owing to the whistling sound made by the wings in flight. The sound is doubtless due to a somewhat smaller wing spread in these ducks than in others in comparison with weight of body. The goldeneyes nest on hollow trees, often twenty or more feet from the ground. The male Barrow goldeneye is a strikingly marked black and white bird; the female is grayish in general, wings blackish, heavily barred with white. The male has a rather large halfmoon patch of white near the bill on the side of his otherwise glossy black head. Another far northern duck is the harlequin. Unlike the goldeneye, the harlequin is not known to breed in the park. It is known here as a winter visitor in limited numbers. Its favorite haunt is in the swiftest streams, and particularly the Yellowstone River. As his name implies, the harlequin is a showy individual, particularly for a duck, - or rather for a drake; the female of the species being quite modestly clad, - and he is one of the least timid of all; apparently he likes to display his remarkable color scheme of slate blue, orange-chestnut, white and black. Among other winter ducks we have the buffle head and the scaups or "blue-bills" of the hunters. The river ducks (those which dabble for their food instead of diving) are numerous. Mallards and green-winged teal are the most common; but widgeon, pintail, shoveler and the beautiful cinnamon teal are not rare. The queer little ruddy duck is also one of our common summer residents. Canada geese are very abundant and "tame". They nest in the park, and at least many of them are permanent residents. During their migrations, flocks of snow geese visit the rivers and meadows, beautiful in their white plumage which is intensified by the jet black tips of the wings.

Eagles

Eagles are always of interest. The king of birds ! The American Emblem ! These synonyms come at once to the mind, consciously or otherwise, at mention of the word"eagle". Yellowstone Park boasts both the bald and the golden species. The former, our national bird, is a resident except for two or three months in the winter. In summer it is especially numerous on the shores of Yellowstone Lake where it nests in the tall trees. Following the shore line in a boat, one may sometimes count six or eight eagles in the space of a dozen miles. In the colder months these birds disperse to all parts of the park, especially to the lower and medium levels, where winter-skilled animals form a staple of their food supply. The golden eagle seeks for its summer residence the higher elevations, nesting on the wildest and most inaccessable mountain ledges, so that the tourist seldom sees it. But, like the Bald, it wanders widely over the park at other times. It is a permanent resident and, even in the coldest weather of January and February, it is sometimes found held fast in a coyote trap set beside a dead horse or elk. There is little difference in the size of the two species not enough to be appreciable in the field. In identifying the birds it should also be borne in mind that the immature bald eagle has a dark head and tail, thus lacking the chief outward marks by which the adult is known. It is seldom that one can surprise these birds or approach them so closely that the difference in the legs may be noted. The feathers extend down to the toes of the golden eagle; only to the heel (what appears to be the knee) of the bald eagle. The bald eagle feeds mainly on carrion, the golden eagle largely on prey of its own killing. Neither species is of any danger to human life. Possibly a child under three or four months of age, if placed beside a golden eagles nest and left to its own devices, might be attacked by the owners of the nest. But my judgment is that it would probably die of exposure first.

The Osprey

Our park does, indeed, boast still another "eagle", and this is the loudest boast of all, the unofficial and inaccurate. It has long been the custom of bus drivers to call the birds "eagles" which nest on the pinnacles in the Canyon and on so-called "Eagle Nest Rock" between Gardiner and Mammoth Hot Springs. These birds, however, are all Ospreys. They return year after year with almost clock-like regularity to their time honored summer homes. Since the establishment of this

area as a National Park in 1872 not a single year has been known to pass without its pair of ospreys and their nest on the mis-named Eagle Nest Rock. Probably that statement goes for most of the ospreys, nest-bearing pinnacles in the Yellowstone Canyon as well. The osprey feeds as its common name "fish-hawk" implies. Much of its food consists of fish found dead, but it also takes a toll of live prey from the water, plunging from a height and grasping the fish with its talons. The latter are very long, sharp and hooked. The entire under side of the toes is provided with remarkably developed spicules - sharp spurs for holding the slippery prey.

Characteristic Yellowstone Birds:

While there is no species of bird peculiar to the region; that is, found in Yellowstone Park and nowhere else, there is, as we said before, so fine a representation of typical Rocky mountain birds that this may be regarded as the chief feature of our avifauna; this particularly for a region so far east of the Pacific. The tourist from the Atlantic states must travel almost, if not quite, as far as the Yellowstone Park before he will find so closely associated the Clarke nutcracker, black-headed jay, Rocky Mountain jay, northern raven, Lewis woodpecker, water ouzel, rosy finch and Townsend solitaire, - not to mention the Barrow goldeneye duck, cinnamon teal and others. It is difficult to say which is the most characteristic bird of the park; but doubtless it is one of those just named - perhaps the Townsend solitaire, especially if something is allowed for a species typical of the Rocky Mountains. This gray, thrush-like bird, in size about the equal of the hermit-thrush, is too timid, solitary and silent to attract general notice; yet the birdstudent will find him quite common and will come to associate him with miles of lodgepole forest, forest clad streams and mountain slopes. The Clarke nutcracker or Clarke crow at once attracts attention of the "tenderfoot", and the eye or ear of the latter 'registers' a new bird. For the ashy gray body and jet black wings and tail of the nutcracker are no less striking than his harsh, distinctive notes. The outer tail feathers and a patch on each wing are white, alike in male or female. Tho this bird is sometimes called "camp robber", these terms are more often and more justly applied to his sometime associate, the Rocky Mountain jay. The latter is about the size and general shape of the blue jay of the east; but there the comparison ends, for instead of the attractive dress of his eastern cousin, the camp robber wears a plain coat of dark gray, darker above than below; the head is nearly white, with a blackish nape. The camp robber seems to crave attention, and he succeeds in spite of his unattractive garb. About the time the tent is pitched or the long unused snowshoe cabin is opened to the unaccustomed air the camp robbers begin to be seen prying about. On soft, noisless wing they swoop gracefully down to points of vantage, ready to hop about the campfire or the door sill of the cabin as soon as crumbs, bacon rinds or other scraps are tossed aside from the first meal; there they pounce upon and at once eat or bear away to a nearby branch. The black-headed jay is the blue jay of the natives - a handsome bird, indeed, much longer of crest and much darker of tint than the eastern bluejay. The raven is common. He bears a close general resemblance to the crow, but is larger and utters various croaking calls, but never the "caw-caw" of the crow. Crows are about as numerous as the ravens in the park, so that very favorable opportunities are offered to compare the two. After all, it is perhaps the little water ouzel which, of all Yellowstone birds, most deserves special mention.

The Highly Interesting Water Ouzel

The ornithologists place the water ouzel in a family by himself; he has no near relatives - not even a second or third cousin by marriage - among our feathered friends. And, indeed, he is an odd fish among birds. About the size of a robin which has lost its tail, the color of a catbird, the shape of a corpulent wren, the ouzel even at first glance impresses one as having that "different" look. When it is added that he sings more in winter than in summer, builds a hut-like nest with the entrance almost thru the floor end, - tho a land bird and without webbed feet, - he swims with the ease of the duck, - then his many fold claim to attention becomes apparent. Yet that is not all. This feathered anomaly, this land bird, walks and gathers his food on the bottom, under the water, of a swift flowing mountain stream with all the nonchalance of a robin hunting worms on a green grassy lawn ! There are always a few pairs of ouzels nesting between the north entrance and Mammoth Hot Springs. Here the nests are placed on rocks in or beside the Gardiner River and from two to four feet above the water. In

some other localities in thepark the nest is located more fully in the spirit of the bird - high on the straight or overhanging side of a cliff over which a stream falls, keeping the mossy nest green in the constant spray. The water ouzel is most often to be seen on the rocks in mid-stream or at least against a background of rushing water, a dark, solitary little figure who bobs up and down at frequent and regular intervals and would look vastly more dignified if only he had a much longer tail. To that bobbing habit the ouzel owes one of his common names - "dipper". While we are on the subject of interesting and unusual birds mention should be made of the phalaropes.

Phalaropes

These are small, swimming snipe. Two species, the northern and Wilson are found here during their migrations, especially in the fall, one or both may very possibly nest sparingly in the park. These birds are usually seen swimming about like miniature ducks on some pond or lake. They are about the size and shape of a spotted sandpiper. In this group it is the females which wear the bright feathers, while the males are clad in the more sober tints. Correlated with this reversal of the usual rule, the dull-colored male phalarope hatches the eggs and cares for the young, while the gayly bedecked wife and mother gads about and leads a life devoid of care and responsibility.

The Western or Louisiana Tanager

This is our representative of the gray scarlet tanager of the east and the summer tanager of the south. Not even those species - famous as they are for exceptional beauty, where fine feathers are so dominant a note in the bird life - surpass our western tanager in attractiveness, tho the color scheme of the latter is widely different from that of either of the other species mentioned. The male of our bird has a bright yellow body, jet black wings, back and tail, the wings barred with yellow and edged with white; the face is orange red. The female is yellowish, olive and gray. The notes of this tanager, like those of the scarlet tanager are rich and pleasing.

Miscellaneous Facts

The largest birds in the park are the trumpeter swan, white pelican and eagles; the smallest are the humming birds, We have at least three species of the latter, so near alike in size that it is like splitting feathers, if not hairs, to be specific in the matter of size. The most attractively colored bird is the western or Louisiana tanager. The most abundant species cannot be determined with certainty. The mountain blue-bird is apparently more abundant in summer than is any other species at any other time of the year. The Clarke nutcracker seems to be the most abundant species in winter. The rarest species is also a problem, for no one can say with finality just which of certain seldom-recorded birds are "rare","casual" or "accidental". But, of the species which are to be found here every year, the trumpeter swan is perhaps the rarest; yet there are several rivals for that questionable honor, for examples, - the harlequin duck, duck hawk, kingbird and catbird. The most important species is another elusive character. All are necessary to maintain Nature's balance. Economically, the western red-taled hawk comes to the forefront - the chief enemy of the ground squirrel. From the standpoint of direct interest to the greatest number of tourists, the osprey is doubtless the most important. He would be missed more than any other one species of bird.

Bird Communities

The writer has mentioned a feature of our bird life - the concentration of birds in certain favorable localities. Space here does not admit of much detail, but I will cite two examples. There is a small lake or pond near Junction Butte which is especially rich in water-birds. Here in the open water or among the flags which border it, are often to be seen Canada geese, mallard, green-winged teal, Barrow goldeneye ducks, ruddy ducks, coots grebes, a colony of yellow-headed blackbirds. Western meadowlarks are especially numerous in the immediate neighborhood. Only half a mile from this little lake, nearer Junction Butte and directly bordering the Cooke City road, is an aspen grove which is highly favored with small birds. Within a three acre space are to be found, nesting.

the red-shafted flicker, tree swallow, western warbling vireo, mountain bluebird and doubtless the sparrowhawk and other species. Camp Roosevelt is another good locality. The woods about this camp are populous with interesting birds; flickers, nutcrackers, western tanagers, chick-a-dees, nuthatches, juncoes, chipping sparrows, robins and others abound. The wonderful song - wonderful especially for so small a musician - of the ruby-crowned kinglet comes from the woods all about. Morning and evening you can hear from the porch, with unfailing regularity, the song of the Audubon hermit thruch, - the finest bird voice in the park.

Hints On Finding and Naming Birds

The following brief remarks are taken from the present writer's book, "Land Birds of Northern New York". They apply as well to bird study in Yellowstone Park as anywhere else. "Carry a pencil and pocket memorandum book and use them on the spot. A field glass or an opera glass is a great help. It is best to dress plainly and to wear stout waterproof shoes. If the sun shines brightly try to keep it at your back, so that your birds when first seen, shall be in a favorable light"., your first glimpse of an elusive bird is of utmost importance, for it may be your last; hence the great importance of good initial, lighting on your subject. The earliest and latest hours of daylight are best, morning preferred for most species. "Above all, aim to see particularly and distintcly. General and inaccurate impressions are of little or no use". When still in doubt of a species, consult a Ranger Naturalist or Naturalist Guide". "The study of birds in the field calls for great patience, just a reasonable amount of caution and, of course, common sense.".

* * * * * * * * * * * * * * * * * * *

SOME YELLOWSTONE PARK BIRDS

By Dr. H. S. Conard
Ex-Chief Ranger Naturalist

Approved by:
Superintendent H. M. Albright,
Mr. E. J. Sawyer, Park Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

Many people find that there are much fewer birds in Yellowstone Park than they expected. That is partly because of the general altitude and partly because one does not see birds anywhere in wild regions without going off of the beaten trails where people are abundant. To see wild birds people must go alone in the quiet fields and woods, and preferably in the early morning.

But it will also be found that there are fewer birds in the region of coniferous or evergreen woods than in the region of deciduous forests. For one thing the coniferous forest is made up of fewer kinds of trees. Here we have many miles of unbroken lodgepole woods, for example. That in itself is unfavorable for variety, because there is no variety in habitat or food. Pines offer nothing to seed eating birds unless they can dig the delectable kernals out of a pine cone. The nutcracker crossbill and pine grosbeak can do that. Then the pines are not infested with as many kinds of insect pests as are the deciduous trees. One or two kinds of insects do fearful damage to our conifers. Witness the ravages of the sawfly near West Yellowstone and the bud worm beyond Garnet Mountain, and right in back of our camp here. But that does not give variety of food for variety of birds. So, no doubt, there are fewer birds, both fewer kinds and fewer individuals, in Yellowstone Park than in a similar area in the central part of New York State. But if you wake up at daylight or are awakened, you will hear a chorus of song that loudly denies the suggestion that birds are scarce. They are really abundant. And 203 species have been seen by experts from time to time. I am no bird man - never way - but my list for two summers number 56 kinds. Let's go out tomorrow and see how many we can spot.

To mention some of the most striking of the park birds, let us begin with the largest and proceed to the smallest.

The largest birds in the park are the white pelican, Canada geese, and the eagles, golden and bald. The golden eagle is a huge creature with six feet spread of wings. A bald eagle was accidentally caught last winter in a coyote trap on Hellroaring Creek, right over here. The wings and tail of a

golden eagle caught in a similar manner and which finally died may be seen in the Museum at Mammoth. It weighed twelve pounds, as big as a good sized turkey. Such a bird might pick up and carry away a young lamb. But does it ? Bailey says that the food of the golden eagle is mostly rodents which it catches alive. Under stress of circumstances it will attack domestic animals. And as the traps show, under still more severe stree it will stoop to eating carrion. You are not likely to see a golden eagle. I have never seen one in the wild.

The bald eagle is fairly common on the shores of Yellowstone Lake. He has been so beloved as our national bird that he has been all but exterminated within the United States proper. He is more common in British Columbia and in Alaska than elsewhere, and a movement is on foot among conservationists to protect the eagle in Alaska and Canada, so that he may not vanish from the earth. This is the way we treat the wild things that we like the most. We shoot our fine game animals and birds until they are about gone. We gather our favorite flowers until the place thereof knows them no more. Too much of our loving, even in the human domain, consists only in a desire to possess. When will we learn that children and wives and husbands and beautiful flowers and all of the graceful and glorious wild things of the earth can give us real pleasure only so far as we delight in their own full free life and self expression. It is more blessed to plant a flower bed than to pick a bouquet. It is more blessed to leave the wild flowers for others to enjoy than to destroy even a few. Isn't it ?

"Bird wing and flower stem -
Make them, who could ?
Bird wing and flower stem -
Break them, who would ?

The"eagles"that you see in the Canyon, and which have a nest in the Gardiner Canyon on the famous Eagle Nest Rock are not eagles at all. They are ospreys or fish hawks, a related but very different bird. Sorry. The bald eagle catches some of its food but prefers to eat dead fish and carrion. Rarely he catches fish for himself, but he prefers to let the osprey do the difficult job. Then as the laden osprey flaps his way home, the bald eagle dashes at him from above, the osprey, helpless, drops his fish in order to escape, the eagle dives and catches the fish in mid air and goes off to <u>his</u> home. He is a dastardly robber, stealing from the brave but peaceful neighbor, jumping on him from the back when he is loaded with game, - or perhaps living on carrion. Such, unfortunately is our national bird - a fit emblem of our imperialists in the opinion of our South American neighbors and the Filipinos. Is there any ground for their feelings ? At any rate, it is our first duty to dispel any such opinion of the American people, and it can not be dispelled by force or exploitation.

The osprey is the big bird that you see nesting on the pinnacles in the Grand Canyon. There is a nest in an old tree down by Garnet Mountain. They build on the same spot, year after year, till the pile of sticks becomes as much as 5 feet in diameter, and five or six feet high. Two or three chicks hatch in this nest, and here they are fed on fresh fish. What an experience it must be when the fledglings make their first flight - launching out on untried wings from an inaccessible needle a thousand feet above the raging river ! The slender wings of the adult stretch five and a half feet, and yet when we see them in the Grand Canyon they look but little larger than a pigeon. That will help us to appreciate the unrealizable stupendous size of the Canyon itself. What relation is the fish-hawk to the eagle ? Well, the old Park manual gives four families of birds of prey: the eagles, the broad winged hawks in one family; next the falcons; then the fish-hawk or osprey in a family by itself; then the owls. Mrs. Bailey includes the fish-hawk in the same family with the hawks. At any rate the eagle and osprey are very different birds, and it is usually only the latter that we see, all of the gearjammers to the contrary notwithstanding.

Our largest hawk and the commonest hereabouts, is the redtailed hawk, generally called the"hen hawk" in the east. Ours here is the western variety. It is the big bird that soars and circles in the sky going up or down without apparent of a wing. There are several nests not far away. Last summer we saw a mother bird at Overhanging Cliff carrying a freshly captured ground squirrel. The baby was in an old tree just below us. The baby was afraid to try to fly and the mother was afraid to come so close to us. After most of us had gone away the baby ventured far enough to make connections with the dinner. The redtailed hawk is very much like its western cousin the Swainson hawk. The latter does not have the red tail. You can often see the tail gleam in the sun as the bird turns and tilts. But the young redtail has not a red tail either for the first year or two. So for my part I cannot distinguish a young redtail from a Swainson. I hope you can. The call of the redtail is a hoarse, sharp scream (imitate).

SOME YELLOWSTONE PARK BIRDS Conard

We see a good many desert sparrow hawks. To me they look just like any other sparrow hawks, and they behave the same. They poise in the air on fast beating wings, to pounce on some stray grasshopper, or sometimes a small bird or mouse.

Then the great horned owl lives here too. I hear him from the hill in the middle of the night: Hoo-o-o-o, hoo, hoo, very deep and hollow (imitate).

The water birds certainly come next in sizr. At the Lake you see the gulls, and if you take a boat to Molly Island, you can see what I have never seen, the famous colony of white pelicans. In our little lakes about here the mallard duck nests. At this season we often see the old birds streaming out to sea, folowed by a mosquito fleet of young ducklings, perhaps a dozen. They are recognized by the dull brown color of the female and young, and the gorgeous green head of the male. In the Bird Lake beyond the Butte we find the Barrow golden-eyes. The male is easily recognized by a large white patch on the side of the head. In this same lake is seen the coot or mud hen, so common all over the continent. He has almost black plumage and an ivory white bill. As you go along the shore of the lake, you hear the loud croaks of the coot, hear a splashing in the rushes, and shortly see a little black gunboat steaming rapidly out into the open water. Grebes are not rare. I once saw a baby one crying for lonliness and fright in the Yellowstone River at Tower Fall. The little fellow was lost from home and was drifting rapidly down stream in the furious current. I wonder if he ever got to shore. Probably some hungry coyote or oversized trout snapped him up.

In August, many a lake has a great blue heron - sometimes two or three. This majestic bird stands 3 or 4 feet high, in shallow water, with his long sharp bill poised, ready to spear an unwary frog, tadpole, or salamander. His coat is mainly of a dull blue gray. I wonder where he comes from in August. Soon after the great blue heron has appeared we may look for the Canada goose. This truly magnificent bird is seen along the Lamar River, and the lakes beyond Junction Butte. The first I ever met were near the mouth of Soda Butte Creek, on the 13th of August, 1924. My small boy and I were sleeping on the ground under the great, starry canopy of heaven. I saw the "great star early droop to rest in the night", saw the brilliant constellations, saw the late moon drifting westward, woke in the morning and saw the hoar-frost all over the grass and on my pillow, and heard the strange unmistakable honk of the wild geese. Last summer, 1925, 150 or more of these fine birds were visited at a lake near Lamar Bridge on our way down from Specimen Ridge. Like everything else in the park, they are much tamer than elsewhere, - but none too tame yet.

Perhaps next in size to the water birds are the crows and ravens and their kin. The crow and the raven are difficult to distinguish unless you have a keen sense of size. The raven is much the larger - half as large again. The raven soars when he flies, going long distances without flapping, also the wings show more sle: .er than the corws, as related to their length. The crow is a flapper. The crow emits the well known "caw caw". The raven has a deep hoarse "walk walk" (imitations). Both eat anything that comes to hand - to bill. They both frequent the bear dumps, or rather the hotel and camp dumps. Both are common. The rangers at our station last year caught two young crows in a nest long before they were able to fly, and raised them by hand. They became very tame and were the source of much entertainment. Tony was especially tame and friendly and inquisitive and mischievious. One day he went over to the window sill and picked up a needle for the victrola, flew with it to the machine - but I interfered before he had time to put it in place ! Another day he came in to the house, picked up a little box of tire valves and carried them out and laid them down on the running board of the car. A man once gave him a dollar. He carried it over to the top of the barn and examined it. Finding it of no further use, he brought it back. He was not so welcome in my cabin. One evening he flew in as we were getting supper, right over the table and dragged his feet in the whipped cream on the desert. Another evening he rode on my shoulder over to the beaver dam to see the beavers swim about. He sat with us in a very well behaved manner. It was dark when we started home and I carried him in my hands. Tony didn't like it. He cawed. I said, "No, Tony, you must ride home. I am afraid you would get lost." Tony rode a little farther, then he looked up at me very crossly, cawed ! .: fiercely and bit my hand. I told him he couldn't go. Then he cawed again, savagely - he has a lot of expression in his voice - and bit me just as savagely. Whereupon I threw him upon the ground. He flew a few feet

with us and then flew up and disappeared in a big Douglas fir tree. I didn't dare report at the station that Tony was lost, two miles away. He had never been anywhere so far away before. But the first thing I heard next morning was Tony's familiar voice. He was downright buisance, but a most diverting pet. His parents used to come to the neighboring trees and he would go up and visit with them, but they always separated again.

Nearly related to the crow is the Rocky Mountain jay, or camp robber. This is a medium sized, pretty, gray bird, the size of a large blackbird. He flies quietly but has no fear of man, at least very little. He is the fellow who will fly down on your breakfast table, snatch a pancake on the wing, go up to a nearby tree, transferring the cake to his bill as he flies, so as to be ready to alight gracefully. There he will cock his shiny black eye at you while he enjoys the pancake and gets ready to do it again. A very similar bird as to size and general outlines is the Clark nutcracker. Both have a harsh cry, but the cry of the nutcracker has a rattle in it, and he lives higher up in the mountains in the summertime. You see him on the way down from the top of Mt. Washburn and along the main line. He has conspicuous white patches on his wings when he flies. He is fond of a drink, and will dive at terrific speed down a precipice to the river below, pulling up gracefully at the bottom, and perhaps once or twice on the way. He feeds his young on selected kernals of pine seeds, preferring the whitebarked pine. So he has to live at high altitudes for that pine rarely appears below 8,000 feet. He is a handsome bird and common. In September he comes down to this level for the winter. The magpie is less common here in summer than in winter. And yet you may have seen him abundantly on your way through North Dakota and Montana. He has a very long tail and a large white patch on each wing; a large bird with a rough voice and rougher habits. He will eat anything that comes to hand. Occasionally one of these birds gets a taste of blood and becomes a really wicked and cruel monster. Up at Upper Soda Butte, and near Cody, you may see the big handsome, crested, black-headed jay. He is rare here and most resembles the jay of Colorado. The eastern bluejay does not come this far west, and the Oregon jay does not come this far east.

We have many woodpeckers. Everybody from east of the 100th meridian must see our red shafted flicker. Where the eastern flicker has a yellow sheen on the under side of the tail and wings this one has a salmon red sheen. He is a handsome fellow. Otherwise he is exactly like the eastern bird; same voice, same size, same habits. In western Iowa and adjacent Nebraska and South Dakota the two forms come together. Occasionally a bird is taken that is intermediate in character between the two and it is believed to be a cross. But I cannot find any record of a pair of mated flickers of which one is red shafted and the other yellow. Until this is observed, the hybrid theory must remain only a theory. Maybe this difference is due to climatic causes or something of the sort. A pair of flickers nested last year (1925) in a hole in an aspen tree in the ranger station yard, just around the hill. We watched the whole process. The young were already hatched when I came on June 27th. Around here the rednaped sapsucker and western hairy woodpecker are sometimes seen.

Right now, out against the evening sky we might be watching the marvelous flight of the nighthawk. He is so much like the eastern nighthawk that only a specialist with a bird in hand can tell the difference. He is recognized by the fact that he flies with the skill and swerving motion of a bat at twilight. But in addition he has very long narrow wings, and on the under side, our side, he has on each wing a white spot that looks like a hole in the wing. He is a good mark for the rifleman. You can always be sure that you have shot him thru the wing. He is closely related to the whippoorwil and has the same enormously wide mouth, so that his lower jaw seems to include the entire lower half of his head. Around the corners of his mouth are long bristles and with these he sweeps thru the air gathering in all of the gnats and mosquitoes he can find. At times he will drop like a shot from the sky at prodigious speed for a few hundred feet, then as he turns suddenly up again in a splendid parabolic curve, his wings cut the air with a deep boom (imitate). It is real sport to watch the nighthawks on a hot summer night, and see them swoop and boom. Of course he is no hawk at all. The nest is on a bare rock or the roof of a house will do, with no sticks or marks whatever. We used to have pebble roofs in Philadelphia and that just suited the nighthawks.

SOME YELLOWSTONE PARK BIRDS Conard

The Yellowstone killdeer is just like the eastern one. The Western mourning dove is like the eastern to you and me. So is the western robin and the western spotted sandpiper. The western meadowlark looks just like the eastern, but he has a ripple in his voice. Some like one better; some like the other. In centrail Iowa both are heard, but the western is more common.

The blackbird of this region is a little fellow known as Brewer's blackbird. The male has a splendid glossy coat, and the female is, as usual, duller. These birds may be seen almost any day on the lawns at Mammoth and also about here. They flock in August and fly away. At the bird lake beyond Junction Butte the redwinged blackbird is found. This is called the thickbilled redwing blackbird, having some technical differences from the eastern kind. But it sings just like the eastern.

On a flaunting flag the red-wing sings
("Onk-o-lee!")
And he dips and sways and tilts his wings
To a rollicking south wind as he sings
("Ka-lonk-o-lee!")
One, two, three,
Nestlings hid where none can see.
("Ka-lonk-o-lee!")

(Weeks)

In the same bulrushes with the redwings is a colony of yellow headed blackbirds. This showy bird has white patches on the wings instead of red and yellow, and the male has a bright yellow head and neck. He is a real sight to behold. You will find him in Wisconsin (John Muir tells of seeing him), in northern Iowa and in Minnesota and from there to Utah at least. If you do not know him, it is worth the hike to the lake to see him. There is only one well known colony of this species in the park, so I am told.

Probably the most beloved bird in the park is the water ouzel or ousel, made famous by John Muir's writings from the Sierras. The ousel is a strictly western bird. It is about the color of the catbird, between the size of the sparrow and the robin, and with a very short tail. But its most striking characteristics relate to its behavior. It inhabits waterfalls or fierce rapids, both in our own Lost Creek back of the Camp, in Tower Creek and in the Yellowstone. One pair monopolizes a stretch of the stream and no other ousel is allowed to remain in those preserves. When resting on a rock the ousel is always courtesying like a well trained English or German child. It isn't a bow or a teeter; it is a quick stoop and rise again (imitate). It does this about every five seconds. Then it steps down to the edge of the water and pecks in the rushing stream for its food. Not finding what it wants, it will walk right down under water, in a current that you or I would not dare move in, run along the bottom, pick a mouthful of food and dart out on another rock, shake himself and look as good as new. This is easily observed by anyone who has a bit of patience. You can sit for a few minutes or hours in the Canyon in back of the Camp, or under the road bridge at Tower Fall. Some of our guests have had the time of their lives on these expeditions.

The ousels stay in the park all the year round. They begin to sing in December, and select their mates in February. Nesting begins in April. We have here, therefore, a bird which has a real married life, and not a mere mating. The nest is built in a rock in the torrent, or under the overhanging curtain of water of a waterfall, or on the brink of a fall. Last summer my younger daughter found the nest on a big rock just at the top of the Lost Creek Fall. It is a hard climb to get there, but she saw the little tuft of moss and grass and saw the baby bird put its head out on one side of the tuft, and saw the parent bird give it food and fly away again. In 1924 there was a nest on a girder underneath the bridge at Tower Fall. At that place a lady watched the baby bird getting its first lesson in flying and hunting food.

Of smaller birds there is a goodly number. At Mammoth you see the Cassin purple finch, a sparrow-like bird with a rich red head. Almost everywhere in the park is the pink sided junco, a gray bird with white feathers on each side of the tail, and very like the junco or snow bird of the east. The white-crowned sparrow is common, easily recognized by the conspicuous white top of the head. The western chipping sparrow nests here and is common. The bird

you are all wanting me to mention is the western tanager. It is rather larger than sparrow size, but the face is bright red and glossy, shading off to bright yellow and on back and sides, accentuated by black wings and tail. The western tanager yellow, red and black where the eastern scarlet tanager is all red and black - a friendly, lovely glint of feathered sunshine, seen almost anywhere over lower elevations in the park.

And then you wanted to know about the mountain blue-bird, perhaps the commonest brilliant bird in the park. The male is brilliant blue all over, except paler below from legs to tail, without the red breast of the eastern bluebird; they are closely related thos, different species of the same genus: Sialia sialis the eastern and Sialia curruccides the western. Blue-birds nest all around here, usually in a hole in a tree. Later in the summer it is a joy to see the families out learning to fly and catch bugs. The young and the females are not quite so gay as the males, but good enough. On my first visit to Excelsior Geyser, we noticed the bluebirds flying in and out thru the steam of the spring. On watching for awhile we detected a nest on a shelf of rock within the edge of the old crater - a modern bluebird, raising her babies by the incubator method. But the Wilson phalarope has that quite beaten. This little bird looks somewhat like a sandpiper, but it swims like a duck. One day I saw a whole fleet of them on the first lake beyond Junction Butte. In this subfamily the female lays the eggs and then forgets about them. Mister incubates the eggs and cares for the babies: the last word in modern domestic felicity. Corresponding with this habit, the female is the more showy bird and the male dresses in drab. Just the reverse is the rule with all other birds.

The song that we hear more than any other, especially in June and July is the song of the golden crowned kinglet. The bird is about as big as your thumb. In the east it is a migrant in the spring and fall. Here it nests. And the thing I cannot understand is how so tiny a sprite can make so far-sounding a song. But it does, and apparently without effort. Then we also have a chickadee, the mountain chickadees, like the eastern one in all of its cunning ways, but with a white stripe over the eye and a black stripe thru the eye. It investigates all of the twigs, hangs on wrong side up as [illegible] cheerfully as right side up, and lives the merriest kind of life. Its miniature dignity is best portrayed in a few verses by my old friend Dr. Leroy Titus Weeks, president of Tabor College, Iowa.

The chickadee tilts
On a sycamore bough.
In cute little kilts
The chickadee tilts,
Like a brownie on stilts
Near his sweet little frau.
The chickadee tilts
On a sycamore bough.

The chicakdee wears
A cunning black cap.
In all his affairs
The chickadee wears
With genial airs,
The dear little chap,
The chickadee wears
A cunning black cap.

The chickadee nests
In a hole in a tree.
The cats are not guests
Where the chickadee nests;
No robber molests
His little tepee.
The chickadee nests
In a hole in a tree.

The chickadee dines
On what do you think ?
Not ices and wines;
The chickadee dines
On lunches he finds
In many a chink.
The chickadee dines
On, - what do you think ?

The chickadee's song
Is "chickadee-dee".
Its not very long,
The chickadees song,
Not much in a throng,
But it satisfies me.
The chickadee's song
Is"chickadee-dee".

* * * * * * * * * * * * * * * * * * *

YELLOWSTONE PARK ALGAE

Compiled by Ranger Marguerite Lindsley

Approved by:
Superintendent H. M. Albright,
Professor W. A. Setchell, University of California,
Dr. H. C. Bumpus, American Association of Museums,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

Visitors to the Yellowstone are nearly always impressed with the beautiful colorings on the hot springs terraces about Mammoth and around almost all of the geysers and springs elsewhere in the park. These colors are due, for the most part, to algae, about which this paper has been prepared.

Alga, (plural algae) from the Latin word alga meaning seaweed. A distinguishing feature of the algae as a group is that they are nourished through their whole surface by the medium in which they live. They are unlike the fungi, which they most closely resemble, in that they are made independent by chlorophyll which is which is an organic substance which gives them and all plants of higher orders their green color and which enables them to use the carbon dioxide of the medium in which they live.

Algae vary in size from the microscopic diatoms and other minute forms found in Yellowstone Park, to sea forms whose stems resemble tree trunks and whose fronds rival the leaves of the palm in size. From the giant kelps of the oceans iodine and bromine may be obtained. Algae are used to some extent as a fertilizer and there are also many edible forms.

There are four large divisions of the Algae. They are the blue-greens, the reds, the browns and the greens. Of these the blue-greens are the most primitive and are the ones with which we are concerned. They are found universally. In moist climates they furnish some of the richest tints of the landscape, growing as they do on rocks, trees and wherever they can gain a foothold. They are found both in salt water and fresh water plankton, a name applied to the floating or weakly swimming, living, organic, material or scum found in all bodies of water. The "red" of the Red Sea is due principally to algae floating in the waters thereof. All over the world we find the blue-green algae associated with thermal waters. As early as 1827 Agardh, a botanist, described the algal growths of thermal waters in Carlsbad, Bohemia. They have been identified and studied in Iceland, New Zealand, the Azores, the Himalayas, Luzon, several parts of the United States and other places. In Pluton Creek, California, in hot, acid water, Brewer claims to have found algae growing at 200 degrees Fahrenheit, which is the highest temperature at which they have been recorded. (biblio, #5) However, Professor Setchell of the University of California tells us that "the old observations at Pluton Creek have never been verified. I, myself, could not find plants were growing in temperatures much over 50 to 60 degrees Centigrade." (122 to 140 degrees Fahrenheit). (biblio. #5).

No organisms, with the possible exception of a few of the bacteria, can withstand the temperature extremes withstood by the algae. In the [illegible] antarctic they were found as the principal vegetation of pools and lakes where they had a four weeks' period of growth at the best, and the rest of the year they were frozen. At times, conditions were so that they were frozen for two or three years without being thawed out at all. Professor Setchell cites Kjellman in a statement regarding marine forms, wherein the latter says that they develop and fruit in water never rising above -1 Centigrade. (30.2 degrees Fahrenheit.)

YELLOWSTONE PARK ALGAE Lindsley

The blue green group of algae is very primitive and the living representatives of today are the descendents, probably little changed, of a group of organisms which were left aside very early in the evolution of plant life. The ability of life to withstand such high temperatures shows possible existence of such forms in the early history of the earth, when it was covered with highly heated mineralized water.

In Yellowstone Park, in 1923, Dr. R. B. Harvey of the University of Minnesota reports, growing in the water of Beryl Spring, a kind of alga at 89 degrees C. (192.2 F.), which is the highest reported temperature at which algae have been found here. (biblio. # periment to show that the temperature of mineral content, actually made it possible for these simple forms to obtain their food without the aid of certain chemically complex agents known as enzymes, which are necessary food in digestion in all of the higher forms. These thermal algae do not have the enzyme diastase, which is used to digest starch, - also they lack other important enzymes.

The part played by the corals and mollusks and others of the animals, in the building of rocks has long been known, but a much more recent discover is the part played by plants. Perhaps the best known example of the latter is the case of diatoms. You have heard of diatomaceous earth which is used as a polishing material and as an absorbent in dynamite. This is a white, silicious material composed entirely of the "glassy" shells of minute algae which , under the microscope, look and fit together like tine celluloid soap-boxes. These plants have the power of utilizing the minute quantity of silica found in all water in building their chells. They are found, to some extent, in these warm waters, but more often in cold water and to some extent nearly everywhere. In the white bands you see on dead trees and stumps in hot spring areas and bogs thru the park, just above the water line you will find diatoms. Silica of such dilute solutions is not readily separable by chemical processes, therefore the diatoms must extract it by some vital process of their own. (biblio. #7).

There are many kinds of blue-green algae in the thermal waters of the park and you will notice widely varied colors. In waters over 150 degrees Fahrenheit, a colorless, filamentous, bacterial growth is found. If the temperature of the water is lower a pale, green yellow algal form appears, sparingly at first and growing more abundantly, and more deeply tinted, as the water becomes cooler to reds, browns, and olive browns, a soft, velvety covering. In rapid currents the algae are in long filaments. In quieter water they are united in a membrane-like sheet, or in jelly masses inflated by gas bubbles tangled in the tissues. where deposition is very rapid the algae are encased in the deposit and only the growing ends of the filaments are exposed and free.

The green forms are not as common in thermal waters as the red and orange forms of the blue-greens, which predominate. However, where the algae have been torn up we will find a layer of blue-green color underneath the yellows. The mushroom shaped forms are conspicuous in many shallow pools throughout the park and especially in the Upper and Lower Geyser Basins.

The blue-green algae are most generally encased in gelatinous material to a greater or lesser degree, and this is what gives the slimy feeling to them. This mucilaginous material, encasing the cells of the algae, is most important in protecting the plants from destruction by drought, making them resistant to drying.

As to the part played by the algae in building up the terraces of both the lime deposits and the silicious deposits of the geysers, it is considerable. In the case of the lime (travertine) deposits, probably they are the greatest factor. In the travertine deposits calcium carbonate is deposited, due largely to the extraction by the algae of carbon dioxide in the water. That algae do actually cause elimination of lime from the water in which it is contained in solution , was shown first by Cohn ('62), and Weed ('88) has given a very able account of the assistance of the blue-green forms in the deposition of travertine and geyserite in Yellowstone Park.

YELLOWSTONE PARK ALGAE Lindsley

The algae of hot springs often grow in gelatinous masses in which a form of silica gradually appears, and ultimately all but the peripheral portion becomes firml; silicified. Weed found the thickness of travertine formed in three days to be from 1/25 to 1/5 mm. In some formations which are deposited rapidly, it is difficult to discover the algal filaments at all, as they are encased in the formation with only the vegetating ends protruding. However, their presence may be demonstrated readily by the use of dilute hydrochloric acid which will dissolve out the lime and leave only a mass of filaments of the algae.

There are two varieties of travertine in which the algae do not enter into the deposition. First, the smooth, glassy formations inside of caves, such as the Devil's kitchen, in which there is a slow deposition caused by crystallization from the superheated solution of carbonate of lime due to the relief of pressure as the water approaches the surface: the second variety is the "hot water ice", the flaky sheets of pure travertine found first on the surface of warm pools and later as scaly flakes on the bottom. These are formed by the diffusion of the carbon dioxide gas due to long exposure.

There is another phase of the blue-green and green algae which will be found interesting to the average person. These are the lichens which are formed by the association of certain algae and fungi, a dual organism. This association of two entirely different groups of the plant kingdom is known as symbiosis, and differs from parasitism, in which one of the plants derives the benefit at the expense of the other, in that symbiosis is where both plants profit, a sort of a mutually beneficial arrangement. A fungus is a plant that is dependent upon organic material for its food. It has no green coloring material, chlorophyll, and therefore it cannot manufacture its own food. The algae are independent in this respect; given sunlight they can manufacture their food thru the agent, chlorophyll, by a process known as photosynthesis (put together by light). In the lichem the fungus fastens itself to a rock or tree where it could not make its own living. It thus becomes a home for the algae, being a means of support which holds the algae up in the sunlight. The fungus in the dual result takes the food which the algae produces and the fungus keeps the upper hand in this partnership by not allowing the algae to multiply except within certain limits. (biblio. #4) In the park we find a fine example of lichen growth in the Golden Gate where the gold coloring of the rocks is due to a covering of them. Lichens are often beautiful, as the "beard moss" of Hiawatha. "- bearded with moss, and with garments green." Their color range is broad and they are often brilliant reds, warm browns, pea greens and others of the more unusual colors in Nature.

It is interesting to know the method of propogation of such forms as the algae. Most of them form reproductive bodies known as spores which are carried by the wind and the water and arecapable of remaining in a resting stage for many months or even years, withstanding much heat, cold or other adverse conditions. For a long time this fact was used as an argument by the men who believed in spontaneous generation, as nothing was then known of these microscopic spores. When a new hot spring starts to come thru the ground the algae will be found growing there within a very short time after it breaks out. It seems miraculous unless one knows how they really managed to get there.

In concluding this brief story of the algae, it will be noted that they are common in various types, thruout the park, being found in cold streams and lakes as well as in the thermal waters. In fact, they are common the world over, from the often frozen waters of the polar regions to the equatorial zones, and in b both fresh and salt water. However, such examples of beautiful coloring as are seen in the thermal waters of the Yellowstone are comparatively rare in the world of the algae.

BIBLIOGRAPHY: The (1) The Americana - 1924. (2) Encyclopedia Britannica-1910. (3) The Standard Cyclopedia of Modern Agriculture. Vol. 1, London. (4) Cambridge Botanical Handbooks, vol. 1, 1916, "Algae". (5) U. S. Geological Survey of the Territories for 1872, by Coulter, Botanist bof the Expedition. (6) Final Report, U. S. Geological Survey of the Territories, 1878, vol. II. (7) The U. S. Geological Survey Ann. Report lx, 1887-8 - Leed - The Formation of travertine and Silicious Sinter by the Veget. of Hot Springs. (8) West, G. S. On Some Algae From Hot Springs, Journal of Botany, July 1902. (9) Fritsch, F. E., Freshwater Algae of the National Antarctic Expedition. Report on Natural History. vol. VI, 1912. (10) Harvey, Dr. R. B., U. of M. Enzymes of Thermal Algae - Science, Nov. 21, 1924 .

FLORA OF YELLOWSTONE NATIONAL PARK (TABULATION)

By Dr. Henry S. Conard,
Ex-Chief Ranger Naturalist.

FLOWERING PLANTS

Abies lasiocarpa
Abronia ammophila
Acer glabrum
Achillea millefolium
Aconitum columbianum
Acteae arguta
Adiantum pedatum
Adoxa moschatellina
Agoseris glauca
dasycephala
pumila
parviflora
purpurea
villosa
Agronvron canimum
scribneri
smithii
spicatum
tenerum
Agrostis hiemalis
humilis
palustris
Allium brevistylum
cernuum
Nuttallii
rubrum
sibiricum
Allocarya scopulorum
Almus tenuifolia
Alopecurus aequalis
alpinus
Amelanchier alnifolia
Elliptica
Anaphalis margaritacea
Androsace filiformis
septentrionalis
Anemone globosa
Angelica pinnata
Anogra Nuttallii
Antennaria arida
corymbosa
lanata
media
oblanceolata
parvifolia
pulcherrima
racemosa
reflexa
rosea
umbrinella
Apocymun androsaemifolium
cannabimum
Aqinlegia flavescens
minima
Arabis ?
Drummondii
exilia
furcatus ?
glabra
Lemmonii
Arabis lignipes
microphylla
Nuttallii
perelegans
Aragallus ?
albiflora
lagopus
Purshii woolly fr.
viscidulus
Arceuthobium americanum
Arctostaphylus uva-ursi
Arenaria congesta
sajanensis
Argentina anserina
Arnica cordifolia
foliosa
fulgens
gracilis
longifolia
mollis
Parryi
Rydbergii
ventorum
Artemisia biennis
cana
discolor (ludoviciana form)
drancunculus
frigida
gnaphalodes
scopulorum
Artemisia tridentata
trifida
vulgaris discolor
Asphlenium
Aster adscendens
angustus
apricus
caerulescens
campestris
Canbyi
conspicuus
elegans
Engclmannii
Fremonti
integrifolius
laetevirens
longifolius
Mearnsii
meritus
proximus
Astragalus aboriginorum
aculeatus
albiflorus
alpinus
carolinianns
Drummondii
elegans
goniatus (A. hypoglottis)
hylophilus
Astragalus mortoni
vexilliflorus
viscidulus

FLORA OF YELLOWSTONE NATIONAL PARK (TABULATION) Conard.

Balsamorrhiza sagittata
Barbarea americana
Batrachium confervoides
flaccidum
Grayanum
Beckmannia erucaeformis
Berberis aquifolium
repens
Betula glandulosa
fontinalis
Blitum capitatum
Botrychium Coulteri
Brassica campestris
Bromus brizoeformis
marginatus
Porteri
tectorum
Calamagrostis inexpansa
canadensis
hyperborea americana
Callitriche palustris
Caltha rotundifolia
Calypso bulbosa
Camassia esculenta
Camelina microcarpa
Campanula rotundifolia
Capsella bursa-pastoris
Cardamine Breweri
unijuga
Cardamine cordifolia
Carex athrostachya
aurea
diandra
canescens
disperma
festivelle
Hoodii
lanuginosa
petasata
Piperi
Preslin
Raynoldsii
rostrata
siccata
vallicola
Carex vesicaria
viridula
xerantica
Carum gairdneri
Castilliea confusa
gracillima
lauta
longispica
lutea
miniata
pallescens
Ceanothus velutinus
Cerastium arvense (C. oreophilum)
vulgatum
Ceratophyllum demersum
Chaenactis Douglasii
achilleaefolia
Chamaenerion augustifolium
Chenopodium album
aridum
Conardii
Fremontii
Chenopodium leptophyllum
murale
salinum (C. glaucum)
Chimaphila umbellata
Chrysopsis depressa
hispida
villosa
Chrysothamnus nauseosus
consimilis speciosus
pumilus
viscidiflorus
pumilus varus
Cirsium foliosum
undulatum
Cicuta occidentalis
Claytonia lanceolata
Clematis Douglasii
ligusticifolia
occidentalis
Cleome pungens
Cogswellia platycarpa
Collinsia parviflora
Collomia linearis
Conandra pallida
Corallorhiza innata
multiflora
striata
Cornus instolonea (C. stolonifera)
Corydalis aurea
Crepis acuminata
elegans
glauca
gracilis
occidentalis
subacaulis
Cryptogramma acrostichoides
Cryptanthe Watsoni
flexuosa
Cymopteris ?
Cystopteris fragilis
Danthonia cusickii
big fr. spermophile grass
Intermedia
unispicata
Dasiophora fruticosa
Disporum trachycarpum
Delphinium cucullatum
Nelsonii
Delphinium Nuttallinium
Deschampsia alpicola
caespitosa
Distichlis spicata
Dodecatheon pauciflorum
Draba andina
incerta
laevicapsula
Nelsonii
ozigosperma
prealta (D. lapilutea)
streptocarpa
Dracocephalum parviflorum
Drymocallis convallaria
pseudorupestris
Eleocharis acicularis
palustris
Elymus condensatus
glaucus
Elaeagnus argentea

FLORA OF YELLOWSTONE NATIONAL PARK (TABULATION) Conard

Epilobium adenocaulon
alpinum
anagallidifolium
Elyna Bellardii Mt. Washburn
with Salik tenera Domin &
Skottsberg
Hornemanii
paniculatum
perplexum
suffruticosum
Equisetum affine (E. hyemale)
arvense
Equisetum laevigatum
Erigeron ?
acris
asper
caespitosus
compositus
discoideus
multifidus
corymbosus
lapiluteus
Erigeron lonchophyllus
luteus
macranthus
microlonchus
radicatus
ramosus
salsuginosus
superbus
uniflorus
ursinus
ursinus gracilis
Eriogonum andinum
heracleiodes
ochroleucus ?
ovalifolium
Piperi
subalpinum
umbellatum
Eriophorum
Eriophyllum integrifolium
Erysimum asperimum
cheiranthoides
inconspicuum
Erythronium grandiflorum
Euphorbia serpyllifolia
Festuca brachyphylla
idahoensis
Fragaria americana
ovalis
platypetala
Frasera speciosa
Fritillaria atropurpurea
pudica (Ochrocodon)
Gaillardia aristata
Galium boreale
trifidum
Triflorum
Gaultheria humifusa
Gaura parviflora
Gayophytum Nuttallii
Gentiana ?
affinis
elegans
plebeja
Geranium Richardsoni
viscosissimum
Geum strictum
Gilia Harknessii
pungens
borealis
Glyceria nervata
pauciflora
Gnaphalium thermale
Grindelia subalpina
Habenaria dilatata
hyperborea
Halerpestes cymbalaria
Hedysrum cinerascens
sulph escens
Helianthus annuus
Nuttallii
scaberrimus
Heracleum lanatum
Heuchera ovalifolia
parvifolia
Williamsonii
Hieracium albiflorum
cynoglossoides
gracile
Scouleri
Hippuris vulgaris
Hordeum jubatum
nodosum
Horkelia gordoni
Hutchinsia procumbens
Hydrophyllum capitatum
Ionactis alpina
Iris missouriensis
Iva axillaris
Juncus balticus
brunnescens
confusus
ensifolius
longistylis
nevadensis
Parryi
Tweedyi
Juniperus scopulorum
sibirica
Kalmia polifolia
cristata
Lactuca pulchella
Lappula caerulescens
erecta
florabunda
occidentalis
subdecumbens
Ledum glandulosum
Lemna cyclostasa
minor
trisulca
Lepidium apetalum
Leptotaenia multifida
Lewisia pygmaea
rediviva
Linnaea americana
Linum Lewisii
Listera nephrophylla
Lithospermum lanceolatum
pilosum ?
Lolium perenne
Lomatium orientale ?
Lonicera ciliata
involucrata
utahensis
Lupinus caespitosus
candicans
leucophyllus
Macounii
parviflorus

Luzula intermedia
parviflora
spicata
Lychnis vespertina
Lycopodium annotinum
Lysiella obtusata
Machaeranthera pulverulenta
Macronema grindelioides
Matricaria suaveolens
Melica spectabilis
Mentha canadensis
Mentzelia dispersa
decapetala
Tweedyi
Mertensia Bakeri subglabra
ciliata
Tweedyi
Mimulus guttatus
Langsforfii
Lewisii
moschatus
Mitelle pentandra
Moehringia lateriflora
Moneses uniflora
Monolepis monotropa hypopitys
hirsuta det. Domin.
Nuttalliana
Montia chamissonis
Muhlenbergia andina
squarrosa ant-hill grass
Myosotis alpestris
Myosurus apetalus (M. aristatus)
Myriophyllum spicatum
Nemophila breviflora
Nuphar polysepalum
Oenothera strigosa
Opuntia polyacantha
Oreastrum alpigineum
Oreostemma Hydeni
Orthocarpus luteus
Oryzopsis hymenoides
Osmorrhija nuda ?
Osmorrhiza obtusa
Oxyria digyna
Polygonum Douglasii
erectum
Hartwrightii
polygaloides
Populus augustifolia
balsamifera
tremuloides
Potamogenton filiformis
lonchitis
natans
pectinatus
praelongus
Potentilla biennis
glaucophylla
gracilis
hippiana
Macounii
millegrana in sedge marsh,
Lost Lake
morridensis
Potentilla Nuttallii
pennsylvanica strigosa
station
viridescens
Wyomingensis
Prunella vulgaris
Prunus melanocarpa
Pseudotsuga taxifolia
Pteridium aquilinum
Pterospora andromedea
Ptilocalais tenuifolia
Pulsatilla hirsutissima
Pyrola asarifolia
incarnata
chlorantha
minor
picta
secunda
Pyrrocoma lanceolata
uniflora
Ranunculus alismellus
alpeophilus
Douglasii
eremogenes
inamoenus
intertextus (natans)
Macounii
Purshii
reptans
Rhus trilobata
Ribes cereum (Small leaf; in
very dry places; fruit
red)
Hudsonianum (Currant-
fls, wh., cold streams
and seeps)
parvulum (small, open
reddish fls. in season)
Ribes setosum (saximontanum)
spring gooseberry.
viscosisimum (currant,
sticky; fruit black)
Roripa hispida
Rosa acicularis
Bourgeauiana ?
Fendleri
Macounii
Rudbeckia occidentalis
Rubus parviflorus
strigosus
Rumex acetosella
britannica ? (crispus ?)
mexicanus
occidentalis
paucifolius
persicarioides
Sagina saginoides
Sagittaria arifolia
Salix anglorum
bebbiana perrostrata
(elk ponds)
cordata
exigua (fluviatilis)
geyeriana
glauca glabrescens
planifolia
pseudomonticola

FLORA OF YELLOWSTONE NATIONAL PARK (TABULATION) Conard

Salix pseudomyrsinites
equalis
scouleriana
tenera
wolfii idahoensis
Sambucus melanocarpa
Sanicula
Sarcobatus vermiculatus
Saxifraga arguta
caespitosa
rhomboides
saximontana
subapetala
Scirpus americanus
occidentalis
Scutellaria galericulata
Sedum integrifolium
stenopetalum
rhodanthum
Selaginella densa
Senecio ?
altus
balsamitae
canus
Purshiana
crossulus
cymbalarioides (fleshy)
Fremonti
glaucescens
hydrophilus
lapathifolus
longipetiolatus
mediocris (Sp. inodit.)
mutabilis
perplexus
serra
submudus
triangularis
Shepherdia canadensis
Sibbaldia procumbens
Sieversia ciliata
turbinatus
Silene Acaulis
antirrhina
multicaulis
Sisyrinchium augustifolium
occidentale
Sitanion hystrix
Sium cicutaefolium
Smelowskia calycina
Smilacina amplexicaulis
Smilacina essilifolia
stellata
Solanum triflorum
Solidago canadensis procera
concinna
dilata
elongata
missouriensis
nana
rubra
scopulorum
serotina
Sophia incisa
Sorbus scopulina
Sparganium augustifolium
Spartina gracilis
Spergularia sparsiflora
Sphaeralcea rivularis
Spiraea lucida
Spraguea multiceps
Spiranthes stricta
Sporobolus asperifolius
brevifolius
nymph springs
poivcoid
Stellaria borealis narrow leaf,
outlet of Lot Lake
crassifolia
Edwardsii
longifolia
longipes
laeta
obtusa lava leaf;
running on rocks below
outlet of Lost Lake
umbellata
Stenotus caespitosus
Stipa columbiana
comata intermedia
richardsoni
williamsii
Streptopus amplexifolius
Symphoricarpus occidentalis
rotundifolius vaccinioides
Synthyris Wyomingensis
Taraxacum ceratophorum
erythrospermum
officinale
Taraxia brevifolia
subacaulis
Tellima bulbifera
parviflora
Tetradymia canescens
Thalesia fasciculata
Thalesia uniflora
Thalictrum dioicum
occidentale
perfect
sparsiflorum
Thelypodium sagittatum
Thermopsis montana
Thlaspi arvense
parviflorum
Tofieldia intermedia
Townsendia Parryi
Tragopogon pratensis
porrifolius
Trifolium hybridum
pratense
repens
Rydbergii
Triglochin maritima
palustris
risetum subpicatum
Trollius albiflorus
Typha latifolia
Urtica gracilis
Utricularia vulgaris

FLORA OF YELLOWSTONE NATIONAL PARK (TABULATION) Conard

Vaccinium membranaceum
scoparium
Veleriana ceratophylla
septentrionalis
wyomingensis
Verbena bracteosa
Veronica americana
peregrina (xalapensis)
scutellata
serpyllifolia
(humifusa)
wormskjoldii
Wicia linearis caespitosa
Viola blanda
linguaefolia
nephrophylla
palustris ?
subvestita
Woodsia oregana
scopulina
Wyethia helianthoides

MOSSES

Riciaceae
Flintans
Reboulia hemisphaerica
Riccia Beyrichiana
Marchantiaceae
Marchantia polymorpha
Bryales
Aulacomnium palustre
Brachythecium collinum
Bryum turbinatum det. Andrews
Ceratodon purpurens
Bukbanmia aphylla
Climacium dendroide
Dicranoweisia crispula
Dicranum strictum
Grimmia ovalis montana
Fontinalis hypnoides
Hypnum aduncum gmcilescens Weed
Leptobryum pyriforme
Orthotrichum rupestre speciosium
Pogonatum alpestre
Pohlia nutans
Polytrichum juniperinum piliferum
Thuidium abietinum

TREES OF YELLOWSTONE PARK

By Miss Herma Albertson

Yellowstone Park is situated in the heart of what is known as the northern Rocky Mountain Forest which lies along the northern half of the main continental divide including central Montana, southern Idaho, eastern Oregon, most of Wyoming, north eastern Utah and small portions in western South Dakota and Nebraska. The forest region of this area for the most part occupies the mountain slopes above 4000 to 5000 feet in elevation on to the timber line at 9000 to 11000 feet above sea level. The lower elevations included in the inter-mountain valleys and plains are treeless.

The forest is largely composed of Western Yellow and Lodgepole Pines, together with a small amount of Douglas Fir, Engelmann Spruce, and a few minor species such as Alpine Fir, Limber Pine, and White Bark Pine at the high elevations. Probably ninety percent of the timber is composed of Western Yellow and Lodgepole Pine, each growing in pure stands, the former at the lower elevations and the latter at the higher elevations.

The forest in this region may be characterized by unusually slow growth, due to the severe climate, the relatively small size and variety of tree growth, abundant natural reproduction of the Lodgepole Pine, the broken nature of the forest due to areas above timber line, open parks at high elevations, and sage brush valleys and plains between mountain ranges.

Although not of great importance in contributing to the Nation's timber supply, the forests of this region are of considerable local importance in supplying mine timbers, railway ties and timbers for local consumption in small town and homestead development. The forests of this region are already under excellent management by the Forest Service and there is every reason to believe that this region will assume great importance in fulfilling its part in the forestry program of the country.

Although Yellowstone Park is located in the midst of the vast arid regions of the west, it has an unusually abundant flora. The climate is much more humid than that of the lower surrounding country and the extremes of heat and cold are less pronounced, hence, the forest growths are abundant, the flowers marvelously profuse, and the grass luxuriant and nutritious.

The total forested area of Yellowstone Park varies with the different authorities, some of whom state that five sixths of the total area is forested, others that eighty-four percent of the area is covered by forests. The trees are practically all coniferous trees, but the species are few in number. It is estimated that three fourths of the total forested area is covered with the Lodgepole Pine, (Pinus Murryana or Pinus contorta), sometimes called black pine from its dark appearance in dense stands.

The name Lodgepole Pine was probably derived from the fact that in August of each year the Indians made journeys to these forests to cut, and peel the light, slender, tapering poles for their lodges and travoys. No other forest tree tapers so gradually, the average being one inch to eight feet. It is the dominant tree at the East, South and West entrances to the Park. The tourist who enters the Park at West Yellowstone passes thru one of the most dense and typical stands of Lodgepole Pine found anywhere in the west. He travels along an avenue lined with tall, dark, slender trunks resembling huge telegraph poles with a Christmas tree on the top. In some places the growths are so dense and the trunks so weak and slender that when the top support is removed, as by clearing the right of way for a road, the trees topple over in great arches until the tops touch the ground. Not only is the tree very flexible but it compares with the Douglas Fir in strength.

Pines are readily distinguished from all other genera of the Coniferae by the fact that the needles are always clustered together in bundles surrounded by a sheath. Lodgepole Pine is the only tree in the Park having two needles. These are usually about two inches long, although they vary from one to three inches due to various ecological factors. It is one of the pitch or hard pines. The average tree is seventy to eighty feet high, with a trunk two to three feet in diameter, but often reaches a height of one hundred fifty feet with a trunk five to six feet in diameter. The bark of the trunk is rarely more than one-fourth of an inch thick and is close and firm, a light orange-brown in color and covered by thin, loosely appressed scales.

TREES OF YELLOWSTONE PARK Albertson

Perhaps the most characteristic feature of the Lodgepole Pine is the clay-colored prickly contorted cone. The cones mature the second season at which time about one-third of them will open. On slow-growing, pitchy trees, or on trees in dense stands, the cones may remain closed ten to twenty years. Some of these resin-bound cones hold their seeds for fifty or even eighty years and are often inclosed in the trunk. Eight percent of these old seeds are known to retain their viability. This "tightwad" habit of holding its cones enables one to distinguish and recognize it at a great distance.

The resin-bound resistant cone accounts for the enormous reproduction of Lodgepole Pine on burned over areas. When forest fires have swept over a region and left only a bed of ashes with here and there a charred trunk or a fire scarred veteran these half burned cones, which have been opened by the heat, send down a shower of seeds. As the mice, squirrels and chipmunks are dead, their hoards are also seed beds. The seeds are very small; about one hundred thousand to a pound. Since a cone averages from ten to fifty seeds and a mature tree twenty thousand to fifty thousand seeds, it is not an uncommon thing to find the young trees coming up the following season as thick as grass. Cloud-bursts, rains, streams, wind and immigrating mice, squirrels and birds help to bury them. As many as three hundred thousand seedlings will spring up to the acre and a fight for survival begins. After the fight has continued for about fifty years the three hundred thousand trees have dwindled down to sixty thousand. These trees stand eight to ten feet high and are no larger than a carpenter's pencil. The forest now resembles a jungle that no large animal can penetrate. By this time survivors of the old forest have fallen and made a mass of crossed poles, rotted at the heart, which form a fire trap that may bring on a second and more devastating fire similar to the one that occurred in the region around Butte and Anaconda.

When seventy five years old the forest is half grown. The lower limbs are pruned off by the wind and snow, or natural pruning occurs due to the lack of sunlight among the lower branches. At the end of a hundred and fifty years about two hundred merchantable trees are left on an acre; more than is possible with any other tree.

A short, yellow mistletoe is everywhere common on the limbs of a Lodgepole Pine. It is not the mistletoe made famous at the holiday season but is much smaller and less attractive, and, we are told, is more harmful to the tree. It wounds the tree and causes witches broom, which in turn brings on an abnormal growth of branches. In winter hundreds of pounds of snow collect on these branches and bend the top over. The central stem recovers its upright position in later growth, but the result is an "S" shaped tree. This has undoubtedly been one of the prime factors in the development of the so-called Knotted Forest on the old road between West Thumb and Lake Camp. Mistletoe is more abundant there than in any other vicinity. These old gnarled and knotted trees have served to help beautify, with a peculiar type of adornment, the curio stores at both Old Faithful and Lake Camps and also add their bit to the rusticness of the Old Faithful Inn.

Because of its shallow root system, Lodgepole Pine is subject to windthrow, and it is not an uncommon sight to see several of the old patriarchs of the woods crash to the ground during a single windstorm. Not only are the roots shallow, but, they parallel the surface of the ground and, hence, have no secure foothold when the test comes. The poet has well said,

"One impulse from the vernal wood
May teach you more of man,
Of moral evil or of good
Than all the sages can."

As the variety and profuseness of animal life depends upon the food supply, the Lodgepole Pine plays its part as a source of food. The thousands of bushels of seed produced on alternate years are not wasted. Pine siskin, crossbills, squirrels, chipmunks, ground squirrels and mice grow fat among the Lodgepoles. The hoards of squirrels sometimes contain ten bushels of cones, all of which are fertile, due to the adeptness of squirrels as seed hunters. Mountain rats eat the bark for moisture in dry seasons, the porcupine lives on the inner bark and girdles many trees, snowshoe rabbits nip the buds of seedlings when other green food is scarce, and even the coney cuts a few limbs for his haystack.

TREES OF YELLOWSTONE PARK Albertson

Forests like those in Yellowstone Park do not yield much sawtimber. The stands average eight thousand feet per acre and seldom run over sixteen thousand. It is a valuable wood for mine timbers because of its toughness. The homesteader found it most valuable for the construction of his buildings, fences and corrals. Lodgepole Pine bids far to be the coming tie timber of the west, and vast acr are now being cut for that purpose as well as for telegraph poles; a use to which it lends itself especially well by nature. Next to spruce and aspen it makes the best paper pulp of any western tree.

As Hawkins has so well said, "Lodgepole Pine then, is not to be despised. Without it Yellowstone Park would be w wind blown plateau sending down great freshets of muddy water. Winding through its pleasant avenues, one may think of it as a loyal friend to man and to all wild life ".

Two other pines are found in the Park, both of which belong to the white or soft pine group. Both have five needles in a cluster, but are readily distinguished from each other by the cones.

The Limber or Rocky Mountain White Pine (Pinus flexilis) is found in the lower altitudes in the northern part of the Park, especially at Mammoth Hot Springs where we see it at its best. It extends up the Yellowstone River to Tower Fall. It is a light loving, drouth resisting tree. In pushing out to obtain light, the lower limbs become long and flexuous. This characteristic of the tree suggested to James, physician to the Long Expedition of 1823, the name Pinus flexilis. They are so pliable that they can be tied in a knot. The needles are clustered at the ends of the branches resembling whisk brooms.

Since the leaves cannot withstand the shade of the branches the tree is rather bare near the center. The tree is usually forty to fifty feet high, with a short trunk two to five feet in diameter. The stout long-persistent branches ultimately form a low, wide, round-topped head. The bark of the young stems and branches is thin, smooth, light gray or silvery white, becoming on old trunks one to two inches thick. It is then brown or nearly black, and divided by deep fissures into broad ridges broken into nearly square plates covered by small closely appressed scales.

The first season the young, green resinous cones, clustered in groups of two to four and usually one half to three fourths of an inch long, stand erect upon the branches. The next summer they grow much more rapidly and reach a length varying from six to ten inches, and turn down on their short stems from the weight. The cones are filled with tasty, brown-speckled nuts a little smaller than an orange seed. In August they drop from the cones and a mad scramble begins among the bears, birds, boys and mice to see who gets the most. However, the squirrels have the best of it, because they begin their harvest a month before the seeds are ripe. It is only the rare occasion when man gets a taste as jays and camp robbers start hammering as soon as the cone shows signs of opening.

In the early days the Snake Indians came over to the eastern slopes of the Rockies to gather the nuts. Because the demand exceeded the supply there are very few seeds left for reproduction and only two percent of those which do germinate can survive the wind and rodents.

Because the roots are lateral, shallow and widespreading the Limber Pine is able to thrive on the "formations", dry boulder morains, and in rock crevices where deep rooted trees would perish. There are a number of fair sized trees growing in the crevices of the great boulders in the Gardiner River.

Limber Pine does not occur in clear stands, but here and there in locations too dry for other trees, it makes a beautiful contribution to the tree life of the Park. Only the juniper can do with less rainfall. No tree in the Park has the aromatic qualities of the Limber Pine. At the first stroke of an axe the woodland becomes an incense garden. It adds its bit to the beauty of America's foremost playground not because of its uniformity but because of its picturesqueness and individuality. It is used as a mine timber and for fuel.

TREES OF YELLOWSTONE PARK Albertson

Closely resembling the Limber Pine is the Whitebark Pine (Pinus albicaulis) a related species of the higher altitudes. It dominates the summits of the lesser mountains of the Park and places of similar elevation where it is low, shrubby pine struggling against all of the odds of an exposed and bleak habitat. It also is so tough that one can tie the limbs into knots. Several trees of considerable size are scattered in the woods above Old Faithful Camp.

The tree is usually twenty to thirty feet high, - rarely sixty feet, generally with a short trunk two to four feet in diameter topped by an irregular, broad head. The bark is thin, except near the base of old trunks, and is broken into thin, narrow, brown or creamy white, plate like scales. Like the balsam, the bark is fairly bursting with sweet smelling pitch which is also healing.

Altho the majority of the Whitebarked pines of the Park are matted, low shrubs with wide-spreading prostrate stems, some of them are very old. A walking stick cut from a tree on Mt. Washburn only three-fourths of an inch in diameter, had one hundred and twenty-five annual rings. John Muir tells of [illegible] White-bark Pines that were growing at the time William the Conqueror landed in England.

Because the trees of the higher elevations are so permeated with pitch they do not rot but are worn away by Nature's sand blast.

The dark Indian red cones one and one half to three inches in length are borne at the top of the tree. The fruit ripens in August but the cone may not open until later. Formerly these large sweet seeds were also gatheres and eaten by the Indians.

This weird and distorted shrub-like tree of Yellowstone's alpine heights bears out the thought of the poet who said:

"There is no northern shore so bleak,
No mountain top so bare,
There is no desert so accursed,
But God's gems blossom there."

For bare as these peaks may be, this hermit of the heights fills his place in the great plan of the Almighty.

Beautiful because of their symmetry and color are the Alpine Fir (Abies lasiocarpa) and Engelmann Spruce (Piced Englemannii) interspread among the White-bark Pine. Contrary to the popular belief among tourists the Alpine Fir, also known as Balsam, is not the Balsam Fir of the northeast, although the balsam of the pustules has the same healing properties. It is found scattered throughout the moister regions of the Park and is the most abundant tree on Uncle Tom's Trail to Lower Falls.

The firs are characterized by a few important features, such as; needles borne singly and leaving a smooth scar when they fall, needles blunt or notched at the end and flattened upon the branches by the slight twisting of the [illegible] petiole and cones borne erect upon the upper third of a spire-pointed top.

The Alpine Fir is easily recognized by the erect plump cones, which resemble Christmas Candles, at the top of the tree. One will seldom be [illegible] rewarded by finding the soft, dark purple cones beneath the tree as the cones disintegrate on the tree and the seeds drop to the ground. According to Hawkins this accounts for the many generations of trees found in a group. They appear as the children, grandchildren and great grandchildren of the mother tree. When she dies they become the chief mourners of the forest group. It often happens that branches pressed into the ground by snow strike root and give rise to a circle of trees around a parent fir. [illegible] Beautiful examples of this are seen on the Nature Trails of Old Faithful.

The thin, silvery-white bark of the young trees and the blue-green of the needles makes a contrast of color never to be forgotten. The bark of the older trees becomes thicker and is roughened by thick, closely appressed, cinnamon-red scales. The bark is covered with pitch blisters which are filled with rank-smelling, viscid balsam whose great curative powers were discovered by the Indians. It forms a sort of new skin over slight abrasions or cuts and is most healing and antiseptic. It has been known to heal a slight wound in the short

period of twenty-four hours. It also has the same soothing properties for the relief of coughs and colds as Canadian Balsam. This tree is of little value except for fuel or paper, but for beauty no tree of the Park can rival it, unless it be the Engelmann Spruce.

In the deep cool, shaded, moist ravines of the Park grows the rival; a dark, blu green, pyramidal-shaped tree of rare beauty and symmetry. In contrast to the Alpine Fir the needles are sharp and pointed, are distributed all around the branches, leave the branches much roughened when they fall and the cones hand pendant from the upper third of the tree. The needles are also square in cross section as compared to the flattened needles of the fir. Surely the Engelmann Spruce is the embodiment of our vision of a perfect Christmas tree. No road is more pleasant to travel, or woodland path more inviting, or mountain stream lovelier, than when winding their respective ways thru a dark, blue-green avenue of spruces.

One half of the forest at the southern entrance of the Park is made up of Spruce. At Apollinaris Spring, Spring Creek and Kepler's Cascade it is the outstanding thing of beauty in the realm of plant life.

Because the young seedlings can withstand shade, it is found in the moist, shaded spots of the Park. It grows side by side with the Douglas Fir, both of which eventually crowd out the Alpine Fir and Lodgepole Pine under whose protection they have germinated and spent their early years of development.

Because the bark is not thicker than a knife blade, fire is one of the spruces worst enemies. On the older trees the bark flakes off in papery scales about the size of a dime. Cones are borne every year but an especially large crop is produced about every third year. The sweeping branches of the parent tree hide the seeds and protect them, hence, it is quite common sight to see the family group of several generations. As the tree grows older is assumes more and more the drooping, sweeping, pyramidal shape due in part to the weight of the needles which remain eight to fifteen years upon the branches. The heavy snows of winter also tend to bear the already laden branches to the ground.

Engelmann Spruce was first discovered by Lewis and Clark on their famous expedition of 1805. Dr. Parry was the first one to notice that it is a separate species from the Black Spruce of the East. There is much controversy among botanists and dendrologists regarding the distinction between Engelmann and Colorado Blue Spruce since the two grade into each other so that only the extreme members of the series can be adequately distinguished.

Spruce is largely manufactured into lumber used in building construction, but is also used for fuel and charcoal. The bark is sometimes used in tanning leather. No other tree at the same elevation produces the quantity of lumber.

Such a tree as the Engelmann Spruce must have inspired Joyce Kilmer to write that beautiful bit of verse:

"I think that I shall never see
A poem lovely as a tree,
A tree whose hungry mouth is pressed,
Against the earth's sweet-flowing breast;
A tree that looks at God all day,
And lifts her leafy arms to pray;
A tree that may in summer wear
A nest of robins in her hair;
Upon whose bosom snow has lain;
Who intimately lives with rain.
Poems are made by fools like me,
But only God can make a tree."

Traveling through the deep shade and dense stands of the northern slopes of the Park one is reminded of the opening lines of Evangeline - -

"This is the forest primeval. The murmuring pines and the hemlocks,
Bearded with moss, and in garments green,
indistinct in the twilight
Stand like druids of old, with voices
sad and prophetic,
Stand like harpers hoar, with beards that
rest on their bosoms."

TREES OF YELLOWSTONE PARK Albertson

Instead of bearded hemlocks and pines the monarch of the Park, Douglas Fir, is the one not only bearded but literally clothed in a so-called green moss, or more properly speaking, a lichen.

As the scientific name of Douglas Fir (Pseudo-tsuga taxiolia) states it is not a true fir. Douglas, whose name the tree bears, considered it midway between the hemlocks and the spruces. The long, pendulous, lateral branches and the bracted cones are the two most characteristic features of Douglas Fir. No other tree in the entire region has the scales of the cone subtended by a three forked bract. The old trees and those of higher altitudes do not bear cones.

Douglas fir grows more rapidly than any other conifer. Together with Engelmann Spruce they form the "Climax Forest", that is, the most highly developed type of forest possible in this region. The stiff, hard wood makes strong dimension timbers, masts, floors, bridges, telegraph and telephone poles. One fourth of all the timber in the United States is Douglas Fir, eighty percent of which is found in Oregon and Washington. The tragedy of it all is that it is being cut twice as fast as it grows, since only three percent of it is held in forest reserves. Will we as Americans ever learn the lesson of conservation of natural resources before it is too late ?

Two other members of the Pine family are found in Yellowstone Park; the so-called Cedars or Junipers. The fruit of the tree, which is a blue berry covered with a white bloom, distinguished the tree from the true cedars, which bear small cones.

The leaves of the Juniper are scale-like and awl-shaped. Those of the Siberian Juniper (Juniperus Siberica) are awl-shaped. This tree would hardly be called a tree by most persons, as it trails over the ground in the shade of Lodgepole Pine and looks like a spreading shrub, sometimes reaching a height of four feet. The green berries scattered along the branches are a year old and the blue, glaucous berries so often seen are two years old. If the animal life of the Park would leave them alone they would remain on the trees for a number of years. The Indians cooked and ate them and the pioneer used them for medicine.

The Rocky Mountain Cedar (Juniperus scopulorum) is the low, evergreen shrub about the "formations" at Mammoth Hot Springs. They are among the oldest living things of the Park. Some of these gnarled and twisted, shreddy-barked veterans of the storms of the decades are over five hundred years of age, although much stunted in size and distorted in shape.

Only one deciduous tree reaches a size of any value or importance in the Park, the Quaking Aspen (Populus tremuloides). It is found all over the region but most abundantly at the lower levels. The greenish-white bark and fresh, green, trembling leaves stand out in marked contrast to the dark sombreness of the coniferous woods.

In the Arabic, the word "aspen" signifies trembling and hence the name is as old as written language. Homer makes mention of the "aspens lancing leaves", referring to their light motion, in his epic of the Odyssey. Geologically speaking aspens are very old, antedating men by thousands of centuries. Because of their trembling and whispering leaves we are told that no one can keep a secret under the aspens.

The aspen may well be called the pioneer of the forest, occupying as it does the burned over areas, preceding other species upon new lands and furnishing shade and holding back the moisture for the struggling seedlings of shade loving and moisture seeking species which follow in its wake. As soon as these hardened trees are large enough to withstand the conditions of the region the pioneer is crowded out and moves farther on to blaze the trail anew.

As all pioneers have a hard time struggling for existence so does the aspen. Its bark is the favorite food of the beaver. They fell the trees and cut the larger ones into two foot lengths, drag them to their ponds and bury them. In the winter they eat the inner bark and then float the poles out into the pond to help make the dam. When the pine nuts are gone the squirrels nibble the bark and buds. Mice often girdle the tree and birds eat the buds in the spring when the

supply of berries is exhausted. In times of famine the elk and deer girdle the aspen groves. Most of the trees bear as black marks the scars resulting from the browsing of deer and elk.

Fortunate is he who visits Mammoth Hot Springs in the autumn, for it is at this season of the year that the aspen lends its brilliant yellow tints to beautify the slopes and ravines. No wonder the poet was inspired to write, "The groves were God's first temples" for, where in all the world can one find the beauty, grandeur and magnificence of the forests of our Continent.

America was especially blessed with natural resources so essential to the life and happiness of mankind and yet how worthlessly we have used them ! When the Pilgrim fathers landed on the "bleak New England shore" 850,000,000 acres of this great land of ours was covered with forests. Today only sixty-five percent of that virgin timber is left. One third of it has been cut or burned and at our present rate of cutting, and burning practically the entire original supply will be exhausted by 1950.

The United States is cutting her timber three times as fast as it is growing. Her per capita consumption is six and a half times as great as that of Germany and twenty times that of Great Britain, but is she enjoying twenty times as much value received ? Thanks to the farsightedness of a few, we now have legislation which regulates to some extent at least, the ruthless cutting and destruction of forests.

Altho the forest has many enemies its worst one is that demon, fire. An average of $50,000,000 worth of timber is destroyed each year, and at least 20,000,000 acres of forest land, or an area nearly four times the size of Massachusetts, is burned over annually. If fires had been prevented on forest lands that are now unproductive on account of their destructive work, four-fifth of the total lumber cut in country could be produced continuously every year on this area. During the season of 1926 an area of approximately 225,000 acres in the Helena district was burned over, and this in the heart of the world's greatest supply of white pine.

In general forest fires are of two kinds; ground and crown fires. Since the greater part of our woods are made up of coniferous trees which shed their leaves only every three to fifteen years, the forest floor does not afford much fuel for king Fire and as a result the crown fire is most common. The crown fire is the most serious type and burns with great rapidity thru the crowns of the trees often consuming everything in its path. Some of the fires have been known to advance at the rate of six to ten miles an hour. It is practically impossible to stop the progress of a crown fire, unless it becomes a ground fire as it passes over the brow of a hill. If such should be the result it can be checked or possibly stopped by trenching.

The forested area of Yellowstone Park has been burned over a number of times as the majority of the present forests are only about one hundred and fifty years old. The Indians have started many of these fires to drive out game to facilitate hunting.

Forest fires in the Park arise from two principal causes: Lightning and the agency of man. Lightning is a frequent cause of fire and one over which man has no control and a danger that, unhappily, will always continue. As long as railroads and settlements are excluded from the Park man-caused fires will not be as great; but, will never be entirely eliminated until every one who visits within its borders realizes his responsibility. When the careless camper learns to thoroughly extinguish his campfire, and the thoughtless smoker to put out his cigarette and cigar stubs before he tosses them aside, the fire hazard will be greatly lessened. One moment of thoughtless careless action on the part of the visitor and those employed in the Park Service may result in the devastation and denudation of the beauty of America's much beloved playground.

When everyone realizes the deepest meaning of that thought back of the founding of the Park embodied in the words over the Gardiner Entrance; then and only then will everyone derive the greatest pleasure from a visit. There is no place for the note of selfishness in the words "For the benefit and enjoyment of all the people."

TREES OF YELLOWSTONE PARK — Albertson

When all who enter the gates of the Park awake to the realization that is there were no trees in the Park, if there were no wild flowers and smaller plants, the place would be desert and accursed; a waste of barren rock, like the Thingvalla, that dreary plain that guards the approach to the geysers of Iceland; then will they all appreciate the indispensableness of the flora and its essentialness for the enjoyment and comfort of all. Too often do we take for granted the most familiar and essential things, never being aware of our blessings until they are denied us.

* * * * * * * * * * * * * * * * * * * *

GUIDE LECTURE FOR MAMMOTH FORMATIONS

By Ranger Marguerite Lindsley

Approved by:
Superintendent H. M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

Introduction: None of the members of the park ranger force are permitted to accept gratuities; they do not expect fees nor will they accept them. The National Park Service provides free guide service at the principal points of interest in the park. Please feel free to ask questions, or give constructive criticism at any time without obligation to me. I hope you will enjoy this trip as much as I usually do.

JUPITER TERRACE: To your right you now see what is known as Jupiter Terrace which is the largest hot spring formation of its kind in existence. We usually think of water as tearing down and wearing away rock as it has done through the years in the many canyons in this part of the world; here, however, we find it building; as high as six, seven or eight inches, or even more in a single season.

This is a comparatively soft formation and is known as travertine. It is composed of calcium carbonate which contains also a trace of magnesium carbonate. At Old Faithful, and elsewhere in the park, the formations are called geyserite, and are composed of silica - hydrous silica as hard as glass, known to scientists as silicious sinter.

Surface water seeping down thru the cracks in the earth, comes into contact with hot lava or steam rising from more deeply buried igneous rock, which, however, is comparatively close to the surface of the earth here, being only a few thousand feet below us. The hot water then rises to the surface, seeking its own level as it does in any ordinary spring. This water in its travels encounters vast beds of limestone, and because it contains carbon dioxide it is capable of taking considerable of the lime into solution. As soon as it reaches the air the gas is given off and the burden of the mineral is deposited on the surface. There are four factors which cause the deposition of this lime as travertine:

1.- Evolution of the carbon dioxide (carbonic acid gas).
2.- Evaporation of the water.
3.- Cooling of the water.
4.- Extraction of carbon dioxide by the algae, tending to precipitate the mineral content of the water.

In those places elsewhere in the park where silicious sinter is being deposited, the action is very much slower as silica is so much less soluble. It takes many years to cover a pencil mark in one of the geyser basins.

Some of the very early visitors to this region attribute the colorings to the presence of the oxides of iron and other minerals. If that were the case, how did they account for the fact that in ten days or less after a portion of that terrace dries up, as it sometimes does, there is not one iota of color left ? The color is due, in fact, to minute bits of living organic matter, microscopic plants called algae, and they are found growing in very hot water. The algae and

other primitive forms of plant and animal life found here are comparable to the most ancient life on the surface of the globe. The lighter colored species always grow in the hottest water and the darker browns, yellows and greens are found where it is cooler.

We are standing in a grove of trees belonging to the great willow family, Populus tremuloides, commonly called aspen, quaking asp, or trembling poplar. Notice the small roundish leaves and the stem flattened sideways, hence the constant wiggling of the leaves. This tree is the main food of the beavers in the Park. The black scars on the bark of these trees are where the elk have nibbled it when the trees were young, or where they have scraped their antlers against it when they are trying to aid in the shedding of the velvet. The magnificent antlers of the elk and deer are growing most of the time. As soon as they are shed in the late winter, growth of the new antler commences. All during this period the horns are covered with a velvet-like skin which is generously filled with blood vessels. The blunt ends are the growing points and are very sensitive and soft. Between eight and nine months are consumed during the growing period, and in the fall of the year the "velvet" splits open and is scraped off, leaving the completely formed antler. This process takes place every year in the males of both the deer and the elk.

Mount Everts, the mountain facing us, is composed of limestone and shale, sedimentary rocks which were laid down in the bottom of a shallow sea which overwhelmed this area during the Cretaceous Period. Specimens of rock from the face of this mountain show fossils of the shell-fish and there is considerable coal to be found there. There is a layer of igneous rock, rhyolite, of comparatively recent date capping the southern end, while the cliff-like face of the mountain shows at its northern end two or three layers of lava embedded in the Cretaceous strata. These were forced in there in the early stages of volcanic activity in the park region. The vertical face of the mountain is due to a fault or break in the rocks. The rock over which we now stand was once on a level with the top of Mount Everts. A great split in the rock occurred, and this side fell in a distance of some 1500 feet. Just such strata as we see in the face of Mount Everts lie buried deep beneath us here. It is from these buried rocks, identical with the unburied rocks of Mount Everts, that the lime of these hot springs is taken. In the geyser region the hot water rises thru volcanic rocks instead of limestone, and hence geyser water contains practically no lime.

The three large hot springs at the top of the terrace are the JUPITER SPRINGS or the MAMMOTH HOT SPRINGS proper. There has been much discussion about the colorings of the various springs throughout the park, making it a most mysterious matter. There is absolutely no color in the water itself. The natural color of clear water in large bodies is blue, and this may be due to the reflection of the sky or the refraction of light or both. At any rate it is a problem for the student of light. One thing you will notice, that where you find beautiful green pools such as Emerald Pool, you will find the bottom and sides lined with yellow algae and all of us know that yellow and blue together make green.

Here in this small area (between JUPITER and ANGEL TERRACES) we find three of the rarer trees of the park growing; the limber pine, the red cedar and the Douglas fir. The principal tree of the park is the lodgepole pine which you will see along the roads, except in the vicinity of Mammoth.

The small twisted trees with shaggy bark are the so-called western red cedar, Juniperus scopulorum. Notice the small, scale like leaves standing opposite each other in pairs.

These trees with the long needles are limber pines. "Limber" because they are very flexible and you can tie their smaller twigs into knots. This is Pinus flexilis of the white pine family and you are able to tell it from the lodgepole pine by the needles. All of the white pines carry their needles in bundles of five while the yellow pines, of which the lodgepole is a member, carry theirs in bundles of two. This tree is seldom found above 7,000 feet.

This large tree is a Douglas fir, one of the finest trees in the park for size and real beauty. It is the Pseudotsuga taxifolia and you can readily disting-

uish it by the extra three lobed scales on the cones. This low shrub growing about its base is the ground juniper or creeping juniper, juniperus communia sibrica. Notice the prickly, flat, pointed leaves, waxy white on the upper surface and set on the stems in threes.

ANGEL TERRACE: This is the Angel Terrace, so called because of the purity of the deposit and the resulting snowy whiteness of the terraces when inactive and the algae are not covering it.

BUNSEN PEAK, the mountain to your extreme left, was named for Robert W. Bunsen, a famous German physicist and the author of Bunsen's theory of geyser action, as well as many laboratory appliances that some of us know very well, such as the Bunsen burner. The mountain is composed of dacite porphery, a volcanic lava.

The mountain next in line to the right of Bunsen Peak is TERRACE MOUNTAIN which is capped with hot spring formation or travertine in a layer hundreds of feet thick, indicating that the formations are very old. On the top of this mountain are found rocks foreign to the vicinity, which were undoubtedly brought by a glacier during one of the three glacial invasions of the northern part of the park. This gives you some idea of the great age of the hot spring formations. Tomorrow when you go out by way of Norris, you will gro through a region known as the Hoodoos, a great chaos of ancient travertine rocks which have been broken and tumbled down from Terrace Mountain.

DEVIL'S KITCHEN is an old hot spring crater about 35 feet deep and possibly 75 feet long. It is interesting to go down into if you want to get some idea of the inside formation on the hot springs. This will give you a good idea of the way in which the whole formation is probably honeycombed beneath us. Another interesting thing about the Kitchen is that it is the home of bats of a southern species very seldom found this far north, but here they live in this cave the whole year through. You can hear them squeaking and if we are very fortunate one may fly out for us even in the day time.

We are now about four hundred feet above the Mammoth Hotel and have come nearly $1\frac{1}{2}$ miles. This is the highest point we attain and there is, consequently, no more climbing.

This is called BATH LAKE and before the plunge at Mammoth Camp was built was a favorite place for swimming. The deepest point under the diving board is eight or nine feet deep. (Experiment - put a paper funnel over the bubbles coming up thru the water and demonstrate the smothering action of the gas (CO_2) which will extinguish the flame of a lighted match.)

The warm, flat rocks around here are very attractive to snakes and we often find them on our walks over the trail. The big ones most often seen are bull snakes and are of the constrictor type. They attain a good size, averaging from six to eight feet in length in the adult snake, and they are not harmful. In fact they are beneficial in that they live on harmful rodents and insects and in a rattle snake country they even kill rattlers. It is against the law to kill snakes in the park and it would be a good thing if people everywhere were educated to know which are the beneficial and which the harmful snakes. There are no harmful ones in the park.

ORANGE SPRING was formerly called Orange Geyser, tho it is not a geyser at all but a hot spring which will probably soon cap itself off. By this I mean that the water will reach its own level, the opening will gradually become stopped up with its own deposit and the water will seek a new outlet. The result will be similar to Liberty Cap, an extinct cone we will see farther on. There are no geysers at Mammoth. Water here is not hot enough to form a geyser - 72° being the highest recorded by Dr. Allen in 1925. Three things are essential for a geyser, according to the most generally accepted theory, Bunsen's, of geyser activity. Concentrated subterranean heat. A long strong tube or reasonably even fissure capable of withstanding great pressure. Water. Surface water seeping through the cracks and fissures fills the tube gradually. The water at the bottom of the tube becomes heated to much above the boiling temperature at the surface because of the great pressure of the weight of the water above it

in the tube. Finally the boiling point of the water in the bottom of the tube is reached and the water starts to bubble and seethe. Some of it is splashed out at the top, thereby lessening the pressure (due to the weight) of the column of water and the remainder in the tube is shot out in the eruption of the geyser.

Just above CLEOPATRA TERRACE:- Here is a good shady place for a bit of history. The first administration building of the park was built on top of Capitol Hill in the form of a blockhouse. This was done as a means of protection, as the Indians were proving quite troublesome. In September 1877 a band of Nez Perce Indians came into Mammoth and killed a man, one of a party of tourists who had been frightened by the Indians in Hayden Valley and were leaving the park. This occurred at the little cabin which stood in Clematis Gulch and which was used as headquarters before the blockhouse was built.

Below us you see, to the right of the Mammoth Hotel, what was for years an army post, Fort Yellowstone, with quarters for four troops of cavalry. Not until 1918 was this fort finally abandoned. The commanding officer of the post was also the superintendent of the park and his men were on all of the stations out in the park, doing the work you will find the rangers doing now. There was considerable dissatisfaction among the enlisted men at being called upon to do this sort of work when they had gone into the army to drill and to learn to become soldiers. So, finally, the Department of the Interior took over the administration of the park and the soldiers were replaced by National Park Rangers. You will find the men in uniform stationed at every station, entrances included, in the park. It is up to them to see that you are given an opportunity to enjoy your trip thru the park, they will answer your questions to the best of their ability. They will find you if you get lost. Their duty is your service. Service to the public in the National Parks is based on the policy of treating everybody in a kindly, friendly and courteous way, and if any members of the party have been treated discourteously or service has not been satisfactory, we would like to have a statement of his experiences which could be given the ranger in the Information Office or to the secretary of the Superintendent in the Administration building, the square, gray building between the hotel and the white Weather Bureau building. Also the tourist is invited to write his criticisms to the Superintendent, Mr. Horace M. Albright.

The building in front of which you see the stack of horns and antlers is the Government Information Office and Museum and there you will find a ranger on duty from 7:30 A. M. until 10:00 P. M., to show you through the Museum or to help you choose your route out through and beyond this park and into others. There are nineteen national parks in all; one in Hawaii, one in Alaska, one off of the coast of Maine, and the rest all in the United States west of the Mississippi River. Of these Yellowstone is the largest and oldest.

The mountain to the west of us here is SEPULCHRE MOUNTAIN and is of early basaltic breccia, a volcanic lava. The name was given because of a very definite rock formation of that shape, the shape of a tomb, which is best seen against the sky line from Gardiner. To the north of us we see the northern end of the Absaroka Mountains, Absaroka meaning "home of the Crow". This is the very high range that bounds the park on the north and east. To the west are the Gallatin Mountains, of which the highest mountain inside the Park is Electric Peak, 11,155 feet. To the south rises the most beautiful range of them all, the Teton Range, and some day we hope that it will become a part of the Yellowstone.

Very little indeed is known of the Yellowstone region before the advent of the white man. The red man whose legends take in all of the country around us have said little or nothing about the Yellowstone. As you know the Indian is most superstitious, and as there was little here that he wanted, with the exception of obsidian for his arrowheads, and as he preferred his purgatory after death rather than before, he stayed away from the land of the evil spirits that he believed this to be.

This is CLEOPATRA TERRACE, so called, perhaps, because it is so very changeable, one year here and the next gone entirely. When active it is one of the most effective of the terraces and photographs well because of the dark background of the hill and trees. This little bush with the bright yellow flowers

is quite a common one here and is known as shrubby cinquefoil, dasiophora fruticosa. It belongs to the same family as the rose. "Cinquefoil" means five leaves and applies to the five leaflets in the compound leaf of the bush.

CAPITOL HILL is a very fine example of a terminal moraine, the dump heap left by a glacier. It was deposited on top of the travertine, showing, again, that the hot springs antedate the glaciers.

HYMEN TERRACE is named after the little god of marriage, Hymen, or more generally known as Cupid. Yonder is LIBERTY CAP of which I told you in connection with the capping off of Orange Spring, and the Devil's Thumb, a similar formation. They are cones of extinct hot springs, considerably harder than the formations around them which may have eroded away, leaving them standing there. However, the surrounding formation is probably the more recent as it is more like the deposit being laid down at the present time. The strata indicate that these were formed by springs which were at the cores of the cones of Liberty Cap and the Devil's Thumb.

This concludes the free guide trip for this morning. The Information Office and the Government Museum, as I have said before, will be open until 10:00 tonight. The exhibits there pertain chiefly to the natural history of the region. I shall be glad to walk down there with those of you who wish to visit it now.

* * * * * * * * * * * * * * * * * * * *

FOUR MILE NATURE STUDY HIKE AT MAMMOTH HOT SPRINGS

By Ranger Dorr Yeager

Approved by:
Superintendent Horace M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Mr. E. J. Sawyer, Park Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

The buildings on your right are the homes of some of the prominent men of the park. The first one is the Haynes Picture Shop where you can get films if you want to. We will go slowly for the next block and give any who wish to get films a chance to catch up. The next building is the home of Mr. Nichols of the Yellowstone Park Hotel Company. The next building is the summer home of Mr. Child, the owner of the hotels.

This will give you the first view of the formations. This one is Hymen Terrace, very delicately colored and is building toward the north. Straight across, the high pointed formation is Liberty Cap. It may have been at one time much larger than that, and have been worn down by erosion. Liberty Cap is really the inner core of an extinct hot spring. There is a hole or crevice up the center where the water used to bubble out bringing with it different minerals in solution, and as it ran down over the sides it threw out of solution these substances and deposied them. Then after a long time the water stopped flowing and erosion set in, wearing it down to the innder core that you see there. A little to the right of it you see another formation that is much similar to Liberty Cap in shape. That is the Devil's Thumb and was formed in the same way as Liberty Cap but is not so old. We will hit the formations at the end of our trip but I will take this opportunity to tell you a little about the formation of these springs. As I said in my talk last night, they are very old. Around Mammoth the formations are largely calcium carbonate or travertine. It builds up very rapidly and wears down very rapidly - is a very soft material. Now calcium carbonate is soluble in hot water containing carbon dioxide. There are vast layers of limestone under us. The water bubbles up, dissolving the limestone and bringing it up in solution. Now if you will notice here at Hymen Terrace, the formation is in the shape of pans or steps, one above the other. That is due to the fact that the hot water containing the travertine in solution bubbles up out of the ground forming a pool. Naturally the water on the outside is cooler than the water on the inside, so the carbonate is thrown out of solution and deposited faster around the outer edge of the pool. This keeps on until the water is almost walled off by this deposit. Well, eventually the pool fills up, overflows and the water forms another pool down below it. The process is repeated. That gives us the effect of pans or steps and if you will notice you will find that practically all of the formations here at Mammoth are built up in that way.

Now about the coloring in the formations. You may have heard that it is due to chemical coloring, but it is not. The coloring in all of the springs, or practically all of them, is due to algae, which are microscopic water plants. The different colors represent different species and these different species grow in the different temperatures of water. So you can be pretty sure that every different color represents a different temperature of water. The grey part on beyond Liberty Cap is all dead formation - that is there are no active springs on it. The algae can only live in the water and as soon as the water stops flowing the algae die, and the color fades. We call that dead formation. There is just one other thing about the formations and that is about walking on them. I'll have more to say about that later but I'll just say here that the formations are very delicate and when they are broken they can never be replaced, so please be careful about throwing sticks or anything on the formations and above all, be careful where you step.

The buildings back of you are the old Fort Yellowstone buildings. Up to 1916 this park was patrolled by soldiers and Mammoth Hot Springs was Fort Yellowstone which played an important part in the history of the early northwest. The buildings were the homes of the commissioned and non-commissioned officers of the old fort. They are now occupied by the park officials;- the superintendent, assistant superintendents, chief electrician, chief engineer, a ranger station, post office, museum, information office, etc. The large open space between us and the buildings was the parade ground of the old fort.

We're going up the Sepulchre Mountain trail. As I said last night it isn't a hard trail. It is a steady climb for the first mile but we are going to rest several times between here and the top and we're going to take it slowly. I don't know how many of you have done any climbing before but for the sake of those who have not I'll tell you what I find to be the easiest way. If you'll take slow, uniform steps - the best way I can describe it is by slow motion pictures. Take the slow uniform steps and keep it up. It isn't climbing that tires a person so much as sudden motions. Running along ahead, sitting down and resting and then running on ahead again - that's what tires you out. Also when you are going up a steep grade lower your hips and cut down the length of your steps, - I think you'll find that helpful. There's just another thing I want to say before we start. I want to take the lead when we start and I want to keep it throughout the trip. There are two reasons for this. First, if I find something I want you to see and someone is fifty yards ahead of the party I'm going to have to waste a lot of breath calling him back and he's going to have to travel an extra hundred yards; and second, if there's any animal on the trail he will be the only person to see it and will ruin the chances of the rest of the party for seeing it. So I want it distinctly understood before we start.

I'm going to ask you to co-operate with me in this hike. This is a nature study hike and naturally different people will see things they want to know about now there are lots of things on this trail that I don't know about and I am going to be free to tell you if I don't know - if I am free to tell you if I don't know, you should feel free to ask me anything you don't know about, - so if you see something that interests you and I don't call your attention to it, just call my attention to it and I will do my best to help you out. Let's go.

Five minutes. Better sit down and get off your feet. You passed several flowers on the trail as we came up that stretch. The fairly high ones looking like little blue stars are false foget-me-nots or stick-seeds. The white ones about eight inches high were wild geraniums and the pink ones the same shape as the white ones are also wild geraniums of a different species. The big, flat unbels of white flowers that you saw about half way up - there are some over there across the creek - are cow parsnips. The ones that look like brown eyed susans are helianthella or mountain sunflower. You will see a lot more flowers as we go on up and it is interesting to see the change in flora as we go higher.

You will notice several different kinds of trees on the trail. We see four kinds of evergreens on this trip. The Douglas firs, the spruces, the pines and the junipers. I'll tell you a little about them now and then I'll show you the difference farther up. The pines are always characterized by having the needles coming out in bunches ranging from 2-5 needles in a bunch, depending on the species. The spruces have the needles spirally arranged and coming out in one place. The fir - that is the Douglas fir, this big one we are sitting under, has the needles coming out one in a place, but the needles are flat and rather soft while in the spruce they are stiff and hard. There is another way of telling a Douglas fir -

if you get a good sample you'll see that the leaves are on both sides of the stem and don't go clear around as they do in the spruce. Somebody the other day said, "It looks as if he had combed his hair parted in the middle." Well, it does look a lot that way and you'll see the resemblance when you get a good specimen. Now the other evergreen is the juniper. I can show you a juniper better than I can tell you about it. Time to go.

Now this is one of the junipers I spoke about back there. This is the erect form, juniperus scopulorum. We will have to wait a little while before I can show you the other species. Notice those trees with a blue tint over there in the ravine to your left. Those are the Colorado blue spruces. They are used in town a lot for landscaping and if you've ever bought them you can appreciate them here. They cost from $5.00 to $15.00 from the nursery-men - we grow them out here for nothing. All right, another five minutes. This water is alright to drink but take it easy. It's the last water you will get for some time but don't drink too much - I don't want to have to carry anyone home. Someone ahead asked me about this flower. That's what we call baby's breath. Anyone know a different name ? Queen Anne's lace is another name for it. These trees are quaking asps, aspens and trembling aspens are other names for them. Watch them for a moment and you'll see why they have that name. They catch the slightest breeze and quiver in it. That is due to a very peculiar construction of the leaf stem. It can move sideways where the ordinary leaf can move only up and down. Those scars on the bark are due to the elk eating the bark in the winter time, or rubbing the "velvet" off their horns on it. I used to say it was due to the elk barking the trees but one day someone told me she didn't know elk barked. All right, time to go.

Now this next stretch is the longest of any of the trip. Notice the scars on the bark of these aspens ? It is hard to find a single tree in this grove that doesn't have a scar on it. Someone reminded me the other day that it would be a dandy hiding place for a zebra. I did see a deer in here one day tho. The trees with the scars so completely camouflaged him that I would have missed him entirely if one of the party had not seen him. Did I tell you that these trees belong to the same family as the cottonwoods ? Notice the shape of the leaf and you'll see they resemble the cottonwood leaf.

The stick-seeds are surely thick up here this time of year. Notice those mushrooms up in the trees ? Anyone have an idea how they get there ? Well, the pine squirrels out here are very fond of them and whenever you see a mushroom up in a tree like that the squirrel has dropped it. Everyone coming back here ? By the way, in case you don't know what this bush is, its sagebrush. Sage tea is made of a different species than this. See that ? It was a Richardson grouse.

Notice those tracks in the mud over to the left. They are deer tracks. The elk make much larger tracks than that and the elk are much higher up at this time of year. We rest at the top of this grade for twenty minutes. All right, another five minutes.

There are several new flowers at this height. These high ones are delphinium or larkspur - yes, you cultivate them in your garden but they don't grow as high as this. The blue, sweet-pea shaped flower on a spike, this one is mountain lupine. If anyone comes from Texas you call it "Texas blue-bonnet" down there.. Then this little blue one is the harebell. Latin name Campanula. Those bright red flowers are Indian paint-brush. You may see them in different colors. I have seen them shade from white to a dark brown. Someone brought me this one. It is fireweed. It is called fireweed because it is the first flower to grow after a forest fire. The color is about the same as that of the wild geranium but the size will always tell it. It is different in shape too. There is a red-tailed hawk - see him ? If he turns just right you can see the flash of his red tail - there, get it ? That is what is commonly called a hen hawk back east, but its very seldom that you'll ever find that follow eating chickens. Time to go.

This is your last climb, so cheer up. The rest of the way is down grade. This big fir tree was in a forest fire some thirty or forty years ago. The fire seems to have killed all of the other trees but this one was only scorched around the base. All right, we stop here for twenty minutes. If any of you smoke, be sure to put out your matches before putting them down. Does anyone have any questions ? If you do ask me and I'll try to answer them. I promised to show you the difference between the evergreens so anyone who is interested come over

here. This little fellow is a Douglas fir, pseudotsuga macronate, which means false hemlock. The way to always tell one of these trees, as I said, by the flat leaves and by the leaves going out on each side of the stem. Remember what I said about having the hair parted in the middle ? This will show what I mean. Another sure way is the cones. Notice this three pointed appendage coming out from under each scale. That is characteristic of this tree. Now this one is a spruce and can always be told by the fact that the needles come out all over the stem and are sharp. We have two kinds here. The Colorado blue spruce and the Engelmann spruce. I once heard that the way to tell them apart was to feel the needles. If they were sharp they were Colorado blue spruce and if they were sharper they were Engelmanns. I won't guarantee to tell the difference that way It is very hard to tell the difference.

Now the pines are very easy because they always have the needles coming out in bunches and not one in a place as do the firs and spruces. That is the way to tell a pine when you see one. The different species are determined by the length and number of the needles. These are limber pines or pinus flexilis. By the way, does anyone know how to tell the age of an evergreen ? Well, a year's growth is represented by the space between two sets of branches. We call a place where a set of branches comes out a whorl and the space between whorls represents one year. For example, if this whorl grew for the year 1922, this space will represent the growth made by the stem in 1923, etc. All right, twenty minutes is up. Be sure to put out your cigarettes and ashes.

This is the best view we will get on the trail of the valley. Across there is Mount Everts, that is the valley of the Gardiner River and the north entrance lie down in that direction. Tower Fall and Camp Roosevelt are up that valley, across there is Bunsen Peak which, as I said last night, is composed largely of rhyolite a volcanic lava. That is Snow Pass and back of us is Sepulchre Mountain. It gets its name from a large sepulchre-shaped rock on the north slope of the mountain which is visible from Gardiner but not here. From now on I wish everyone would be a little more quiet than usual because we are going to enter the timber and we will have more of a chance of seeing animals.

We are turning off now on to the Snow Pass trail. This trail leads up from Mammoth and up into the Pass and out upon Swan Lake Flats. Notice the soil, it is calcium carbonate. At one time the formations were this far up the hill. That must have been a long time ago because several places along here you will be able to see signs of glacial action on rocks which shows that the formations were up here when the glaciers came. Now look where the springs are. How long it took for them to get to their present location no one knows.

From here down you will see that the soil is made up of this hot spring formation and when you strike the formations you will see that there is nothing else but travertine. This is the trailing juniper of which I spoke. Take one of the berries and crush it. Recognize the smell ? These are the berries from which they make gin. This bush has the latin name of juniperus siberica.

These shells are interesting. Has anyone an explanation of how these small snail shells got here a mile and a half from the nearest water ? No, they were not left when the water receded. If they had been they would have been destroyed and covered up a thousand years ago. The only way I can explain it to you is using part of the theory of evolution. These snails are land snails and are the direct descendents of the water snails that lived here when water covered this country. But as the water gradually subsided the snails adapted themselves to their new environment or perished. They wisely chose the former course and here we have a new species which is perfectly fitted to its environment. You'll find these under logs and rocks along the trail.

Now around the next turn we shall see probably a couple of mantled marmots or ground hogs. They are always up there sunning themselves and if we go quietly and don't make any sudden moves we can pass right under them. There they are. Be careful and don't frighten them. They are very closely related to the eastern ground hog or wood chuck. Practically the same thing. Here is a bunch of fringed gentians - the largest bunch that I know anything about in this section. Be careful of them and do not pick them because tomorrow's party will want to see them too.

FOUR MILE NATURE STUDY HIKE AT MAMMOTH HOT SPRINGS Yeager

Here we are at the formations. This is called Soda Spring. It's the same kind of water that you pay five cents a glass for over the soda counter except that is cold and this is warm.

- - - - - - - - - - - - - - -

The rest of the trip is purely formation guiding and does not belong in the field of nature study, altho I always brought my nature study parties back over the formations as it was the only chance some of them had to view the springs.

This is, of course, but a rough sketch of the things covered. Things would come up in the course of the trip to vary the conversation and talk from time to time, but generally speaking, this is about the field covered daily.

* * * * * * * * * * * * * * * *

ELECTRIC PEAK

By Ansel F. Hall, Chief Naturalist,
Mrs. Harriette Harte Roter, Asst.

Electric Peak, the highest mountain in the Park, was ascended first on July 26th, 1872, by three members of the 1872 Geological Survey: Dr. A. C. Peale, the mineralogist of the Survey, Mr. Henry Gannett, the astronomer and Mr. A. E. Brown, the assistant topographer. Dr. Peale's account of the ascent is as follows:

"On the morning of the 26th of July Messrs. Gannett, Brown and myself started to make the ascent of the peak which lay to the southwest of the camp. Our way was up a long ridge which seemed to us to lead to the summit of the peak. The rocks immediately beneath us were cretaceous sandstones. On reaching the timber line (9,442 feet above sea level) we found that we would have to finish the ascent on foot, as the slope became too steep for the horses. So dismounting, we picketed them and started for the summit. The sandstones over which we passed reach within five hundred feet of the top, dipping to the northwest. The summit of the peak seemed to be made up of an immense pile of broken up volcanic rock (a rusty-gray trachyte). When we were within about five hundred feet of the top a storm came up and we were enveloped in clouds. The ascent here was very difficult, as the fragments of rock were very sharp, and most of them loose sliding beneath us as we climbed over them. Mr. Gannett succeeded in attaining the highest point and depositing his instruments, when he discovered that he was in the midst of an electrical cloud and his feelings not being of the most agreeable sort he retreated. As he neared us we observed that his hair was standing on end as though he were on an electrical stool, and we could hear a series of snapping sounds, as though he were receiving the charges of a number of electrical frictional machines. Mr. Brown next tried to go up, but received a shock that deterred him. The cloud now began to settle about us, and we descended to some five hundred feet and waited until the storm passed over. About four o'clock in the afternoon we succeeded in reaching the top and Mr. Gannett found the altitude of the peak to be 10,992 feet above the sea."

- - Hayden: U. S. Geological Survey of Montana
Idaho, Wyoming, Utah 1872.

THE NORRIS ROAD

By Charles Phillips
1890 - 1927

An even half century ago Philetus W. Norris became Superintendent of Yellowstone National Park, succeeding Nathaniel Pitt Langford, the Park's first Superintendent. The colonel (for he picked up this title somewhere in his long and varied career) was one of the most picturesque figures in the history of the Park. Among other things he was a voluminous author but his gift of rhetoric makes his reports rather unsatisfactory evidence for later investigators.

Undoubtedly the greatest service Col. Norris performed in his five year administration was the road he built from Mammoth Hot Springs to Old Faithful. The "Norris Road" opened up nearly half the Park and put the geyser regions (then regarded as the chief points of interest) within the reach of travelers even before the railway reached its gates.

The old road, while it would be regarded as primitive in the extreme by present engineering standards, served a useful purpose in its day and does not deserve the oblivion into which it is rapidly passing. True, none of it is utilized by the present loop system but many miles of it are traversed by hikers and saddle horse parties who are quite unaware of the historical significance of the route over which they are passing.

None of the present roads at Mammoth were then in existence, in fact, none were needed for the parade-ground was a broad, level stretch of glaring, white travertine formation. The road to Old Faithful started at the Devil's Thumb and this first incline is now part of the Terrace Trail. The road, however, did not swing back on to the formation but stayed in the fringe of trees on the right, passing the west end of Narrow Gauge Terrace. Here it dropped into the ravine that leads past Orange Spring; this section is now part of the "formation road".

Just beyond the Soda Spring it turned to the right and started the climb to Snow Pass. The present Snow Pass Trail is on the grade of the road from here to well past Summit Lake. After emerging from the Pass it swung southward and headed directly for the site of the present Seven Mile Bridge passing near Swan Lake enroute. The Gardiner River and Obsidian Creek were forded and the road held approximately to the present route to Obsidian Cliff although somewhat nearer the bank of Obsidian Creek.

At Obsidian Cliff occurred the celebrated episode of heating the volcanic glass with huge fires and dashing cold water on it, thus splintering it to fragments and making it possible to handle the refractory material by the primitive methods then available. The Colonel's work at this point was well done and the road bed he so laboriously cut across the foot of the cliff is still in use.

At Lemonade Creek the road forsook the water-grade and started up the side of the mountain. The incline is very steep and the climb was the most arduous part of the entire journey. The divide once surmounted ten delightful miles lay before the traveler. The road skirted the shores of the Lake of the Woods (then called Gibbon Lake), a forest-girt body of water that is the summer home of the Park's shyest water fowl. It soon dropped to the head of Solfatara Creek, at that time regarded as the main stream of the Gibbon River and so called, and followed it to its junction with the present Gibbon. The Solfatara valley has a quiet, pastoral beauty that is unique in a region so permeated with supernatural and diabolical elements and it is unfortunate that it could not be retained in the present road system although to do so would sacrifice Roaring Mountain, Twin Lakes and the Frying Pan.

The road swung in at the side of the Norris Ranger Station and, fording the Gibbon on the site of the pole-bridge, continued along the present route past the Geyser Basin to the Black Growler. The side road here to the Bath Tub is the Norris Road and it dropped down the other side of the hill to the Minute Man Geyser. The Howard Eaton Trail utilizes the old road for several miles from this point. It left the basin to the left of the present road and stayed high in the timber above Elk Park. It descended into Gibbon Meadows in the northeast corner, at which point the trail abandons it, and crossed the meadow in a direct line to the head of Gibbon Canyon. The present road co-incides with it for a half mile but leaves it . . to cross the river at the five mile post. The old road continued on the east side of the river and much of it is visible as the Howard Eaton Trail from the loop road.

THE NORRIS ROAD Phillips

At Gibbon Falls the road left the river and headed southward for the Firehole. The early builders did not venture a descent into the canyon which now forms such an attractive part of the loop road; their road, in fact, did not approach the river until just below the Fountain Ranger Station.

The ford across Nez Perce Creek was somewhat above the present bridge but the road rounded the foot of Porcupine Hill on about the present grade. Passing the butte it swung to the edge of the timber on the left to avoid the marshy floor of the basin. Several springs provided good water at this point and made it the favorite camp site in the lower basin. The old road crossed the loop road just behind the Fountain Hotel and turned sharply to the right crossing the formation on a low ridge and encountering the river about due west of the site of the hotel.

For several miles it followed the east bank of the Firehole closely and may be seen as the Howard Eaton Trail below the highway opposite the overflow of Excelsior Geyser. It crossed the loop road a second time at the lower Excelsior bridge and followed the river around the big bend almost at the water's edge, coming in again a quarter mile above the upper Excelsior bridge.

Here again the highway uses a couple of miles of the old roadbed. The branch road to Biscuit Basin marks the point of divergence and it followed the river bank from this point on. It passed below Artesian Geyser and the ruts are still quite distinct in the formation beside the cone of Restless Geyser. It comes into the present system again at the Morning Glory side-road which it joins just before the Sentinel Geyser.

Riverside Geyser marked the terminus of the Norris Road and the Morning Glory loop constituted its last section. Early travelers usually camped on the site above Riverside, one of the few points in the Upper Basin where good water was available. The Camp Ground on the site of Old Faithful Inn was less favorably situated in this respect but was much used on account of the panoramic view it afforded of the entire basin.

THE NORRIS GEYSER BASIN

By Charles Phillips
1890 - 1927

While the Norris Geyser Basin is the first of the three geyser basins on the loop road to be encountered by the majority of Park visitors, it was the last of the three to be discovered. This was due to the fact that the early explorers of the region entered either by way of the Yellowstone River or the Madison and Fire hole Rivers both of which routes passed too far from the basin in question to reveal any clue of its whereabouts.

The Norris Basin was discovered in 1872, the year in which the Yellowstone was made a National Park and two years after the Washburn-Doane expedition had discovered the Upper and Lower Geyser Basins. This basin was first seen by Dwight Woodruff and E. S. Topping whose attention was attracted in its direction by observing the steam column from Bunsen Peak 15 miles to the north.

The region was known for a number of years as the Gibbon Geyser Basin. Later it was renamed the Norris Geyser Basin for "Colonel" Philetus W. Norris, the second superintendent of the Park who held that office from 1877 to 1882. Col. Norris was one of the most picturesque figures in the history of the Park; he was a poet and literary man as well as executive and his writings did much to bring the Park before the public during his administration. He built the first road in the reservation making the three geyser basins accessible to travelers. The present road system does not follow, for the most part, the grades of Col. Norris' road, but much of it is utilized by the Howard Eaton Trail.

The Norris Basin is the "geyser basin" par excellence of the park. It fulfills more than any of the other four one's mental picture of all that the term suggests - a vast bowl-shaped depression in the earths crust, its floor a seething mass of spurting jets of water and its rims perforated by steam vents whose deafening roar and withering heat fairly take the on-looker's breath away. Here, where the very ground boils and bubbles under one's feet the visitor is brought face to face, as in no other part of the Park, with the forces that have made the Yellowstone what it is and his comments invariably reflect that emotion, whether they be a scholarly allusion to Dante's Inferno or a "sage-brusher" observation that "this sure is the lid on Hades and it aint clamped down very tight either."

But however fascinating the region is to the casual visitor to whom it appeals chiefly by stimulating that sense of the supernatural that lies deep within our subconscious, it is doubly so to the scientist trying to fathom the secrets of the processes going on far beneath the surface. Here he may find geysers in all stages of their development from vents that have broken through the earth's crust within the history of the Park to crumbled cones that bespeak an age scarcely less than the venerable giants of the Upper Basin. From a chemical and physical point of view this basin presents many problems whose solution would add much to our knowledge of geyser activity - the relationship of acid and alkiline waters the peculiar forms of the sinter, the abundance of arsenic compounds, and numberless others.

In the stage-coach days a noonday stop was made at the Norris Lunch Station and after lunch a guide-party was taken over the formation, starting at the board-walk at the foot of the slope in front of the station. Inasmuch as the majority of the present day tourists begin their brief inspection of the basin from this point - or, at any rate, pull up here if they are indisposed to a nearer view than can be obtained from the cushions it would seem advisable to make the old lunch station the start of a descriptive survey of the area.

Before descending the slope to the board-walk the visitor's attention is attracted to a roaring vent to the right. This is a comparatively new opening and is as yet unnamed; it registers a temperature of 218°, about 20 degrees above the boiling point for this elevation. Still farther to the right along the slope are the remains of many cones and extensive sheets of sinter that indicate this section was formerly much more active than at present. The nature of the sinter is unlike any that is being formed elsewhere in the Park and bears a superficial resemblance to some forms of travertine at Mammoth Hot Springs. About 200 yards to the northwest is Sieve Lake, a shallow body of water whose bottom is so perforated with gas vents that the name is well chosen.

THE NORRIS GEYSER BASIN Phillips

At the beginning of the board-walk, on the left, are two similar springs that rival Twin Lakes in their color contrast, the first being deep blue and the other apple-green. The green color of many of the springs in the basin is due to a lining of sulphur the yellow of which passing through the blue of the water produces greens of varying shades depending on the intensity of the yellow and depth of the water. Both springs are geysers, the blue one erupting to a height of 15 feet. A short distance farther on the right is Onyx Spring which in late years has alternated between a small geyser and a steam vent and has lost most of the color that gave it its name. To the left in the center of the floor is Iris Spring, a large sapphire-blue pool that surges almost in geyser fashion at irregular intervals. Beyond is Arsenic Spring whose miniature terraces gleam brilliantly in the backlight of the morning sun. The vivid orange and green tints of this formation are not due to arsenic, for the spring contains no more arsenic than the other waters of the basin, but is a film like growth of algae, orange in the warmer and green in the cooler streams of the heated water.

At the end of the board-walk are two geysers that are so regular and so frequent that they are seen even by all the four-and-a-half-dayers who "do" the basin on a dog trot. The first, Constant Geyser, though small is scarcely excelled by any geyser in the Park for grace and symmetry. It plays to a height of 35 feet every 65 seconds (1926). Its neighbor, Whirligig, plays for periods of 15 minutes with intervals between eruptions of the same duration. The latter's chief point of interest is the sound produced by the small oblique vent that resembles to a marked degree a locomotive struggling with a heavy freight train on a mountain grade. A third vent, forming an equilateral triangle with the two above, plays simultaneously with occasional eruptions of Whirligig. Another crater at the base of the hill behind Whirligig plays a few feet at intervals and rarely to a height equal to Constant. Farther down the slope is Crown Spring, now extinct, that is conspicuous for its peculiar coronet-like formation. Still farther and back in a small ampitheater on the slope is Ebony Spring whose eruptions are unfortunately among the rare events of the Norris Basin for it is one of the most attractive geysers in the region. It attains a height of 60 feet.

Retracing his steps a short distance back along the board-walk the tourist encounters another walk leading to the auto road. On the left of this walk are two geysers, both unnamed. The first is infrequent but 40 feet . when in action. The second plays for half a day at a time several times a week; the maximum height of 25 feet is held only during the first few minutes. Beyond, on the same side, is a large boiling pool that during the season of 1926 developed powerful geyseric action at its east end; its future developments will be watched with interest. Above and evidently on the same fissure is Hurricane, a famous old vent that has lost much of its pristine strength but still churns its vat of pyrite mud in a manner that gives sensitive on-lookers the"creeps"

As the visitor ascends the trail to the road he encounters the three vents of the Mud Geyser at present the largest geyser in the basin. Two of the vents are active while the third acts somewhat as an indicator, filling slowly during the interval between eruptions and draining rapidly as the other two vents play. One stream is thrown horizontally in an arc that measures well over a hundred feet while the vertical jet reaches a height of 75 feet. The two jets sometimes play alternately, sometimes simultaneously in which case neither attains the maximum given above. This geyser is extremely irregular; in 1926 its intervals varied from two days to seven weeks.

The most noteworth feature of Valentine Geyser nearby . is the deep crater-like pit in which it lies. This cavity, like all the openings on this side of the basin, has been blown out by a steam explosion or possibly bit by bit in a series of explosions. The Valentine is unusual in the fact that its tube descends more than 60 feet without a turn. This gives the water great momentum and enables the jet to attain a considerably greater elevation (80 feet) than the power of the geyser would warrant. Water is ejected for only a few minutes and is followed by a vigorous steam period for several hours.

Below Valentine is a very active vent that plays frequently but irregularly out of a deep cleft in the rhyolite. It is remarkable chiefly for the manner in which it has coated and cemented together the trees that have fallen across the vent with sinter of a pearly black lustre whose color is due to pyrite (FeS_2). A hundred yards farther down this side of the basin at the foot of the slope below the road are several springs of an unusual nature. One of this group has built itself a cone of the type, although on a much smaller scale, that is char-

acteristic of the Monument Geyser Basin (see below).

As the visitor climbs the trail on the slope above the Mud Geyser he approaches the vent whose steadily increasing roar has grown on his attention as he has progressed down the board-walk until at close quarters all conversation is impossible. This is the Black Growler, perhaps the best known single feature in the Basin. It has the distinction of being the hottest steam vent in the Park with a temperature of 284°, a superheat of nearly 90 degrees. Noisy as it is, it was far more so several years previous when the vent was newly broken through the crust and had not yet been enlarged to its present size by the pressure of the confined steam.

Those tourists who have not made the trip from the lunch station via the board-walk but who have driven to this point by way of the road will have observed the features just described only at long range but will have seen others that the pedestrians have missed. On the right as the road passes the lunch station are the Opal Springs; here brilliant orange deposits on the lining of the spring shining through the azure blue water produces an effect strikingly like a Mexican fire-opal. Nearby are the Grindstone Springs whose flat cones resemble grindstones lying on their sides. Across the road is a large body of water whose name, Nuphar Lake, is taken from the scientific name of the yellow water-lily, a Greek term which in turn is derived from the Egyptian where it applied to the lily of the Nile. Beyond on the same side of the road is Congress Pool which to veterans of the World War will recall nothing so much as a large shell crater. It was formerly quite active both as a geyser and steam vent. It is said to be named for the 53rd Congress (1893) which in a like manner promised great things for the Park but was equally inactive. Beside Congress Pool is a small paint-pot, the only one near the road in the basin. A drive of a few hundred feet brings us to the Black Growler again.

Across the road from the Growler less than a hundred yards back in the timber, most of which has been killed by heat, is a comparatively new vent originally called Tippecanoe but renamed Harding Geyser as it became unusually active just before the visit of the late President in 1923. The abandoned grade of the old road which forms the beginning of the trail to the east side of the basin first passes the Bath-tub which bore a closer resemblance to that household utensil in former years when it did not boil so violently but filled quietly from one end of its long narrow crater. Thence the trail leads on past Emerald Pool, unfortunately named, for the spring though attractive enough in itself suffers from the inevitable comparison with the pool of the same name at the Upper Basin. As the trail drops down the farther side of the hill the tourist encounters New Crater Geyser which might be accurately described as a subterranean geyser for its vent is so deep in a fissure that the jet scarcely reaches ten feet above the surface of the ground. As its name indicated it is of recent; Col. Norris states that it came into existence August 11th, 1878. The deep red color of the sinter is due to oxide of iron which also gives the following vent its characteristic color.

Echinus Geyser is without doubt the most beautiful, at any rate in coloration, of all the springs in the Norris Basin. The blue-green of the water and the maroon of the surrounding sinter make a color combination that is unique in the entire park. It is so named because the pebbles around the basin are so covered with spiny sinter that they resemble sea-urchins (echinoderms). The outlet of Echinus one hundred yards below the latter flows past a boiling spring that at times is a small but powerful geyser. It is notable for the arabesque-like forms the sinter has taken. It may be remarked here that this spiny form of sinter is found nowhere else in the Park; why it should occur only at Norris Basin and especially in this part of the basin is as yet an unsolved problem.

The old trail now follows the foot of the hill on the right although it has been practically obliterated by time. As it swings sharply to the right to return to the road it passes Veteran Geyser. Here the original vent has been closed by sinter deposit or by an obstruction and the geyser has forced a passage alongside of the former opening so that the jet is now shot obliquely from under the rim into the crater. Not far from the Veteran is the Corporal Geyser, a periodic spring that fills and overflows at irregular intervals. The eruptions of Fearless Geyser are too small to attract attention. The geyser is unusual, however, in the quantity of carbonic acid gas given off in eruption. The sinter

here takes a peculiar form that has been likened to the seeds of the nasturtium. A neighboring spring, the Palpitator, though small and frequently inactive is quite unique even among the vast number of similar phenomena in the region as it beats in an uncanny rhythn like the pulse of some subterranean monster.

The visitor is now at Monarch Geyser which was formerly the largest geyser in the Norris Basin playing at a height of 125 feet. It has been dormant for a number of years and there is no record of an eruption since 1913. The old platform still standing between the Minute Man Geyser and the auto road marks the terminus of the former trail. Here the party was loaded onto the waiting stages that were to take them on to Fountain Hotel. The Minute Man is not as regular as its name would indicate. Some years it plays every twenty or thirty seconds, others the interval may be several minutes. Occasionally it plays continuously for days and then is dormant for several weeks.

As the tourist has followed this old trail he has observed to his left a vast area with many steaming vents and an occasional spouting geyser. If he is in a mood for further exploration it will repay him to return to Fearless Geyser and proceed thence a hundred yards south to Vixen - a temperamental creature of uncertain disposition, some days quite dormant and others a spurting spit-fire that bids the on-looker keep his distance. Pearl Geyser just beyond is a striking contrast. Here the sinter has a soft lustrous texture and the beads around the crater gleam like pearls. The crater is of the morning-glory type and the water pale green. Only one eruption was observed in 1926; the water was ejected in a fan-shaped jet while the contents of the pool surged over the rim in a series of pulsations that might account for the miniature terraces of the surrounding formation if the eruptions were frequent enough. Perhaps they were in the old days. Near Pearl Geyser is a steam vent whose noise would indicate considerable pressure although the thermometer indicates only a few degrees of superheat; it is also noteworth for having the only trace of realgar (arsenic bisulphide) in this part of the basin.

Pebble Geyser whose cone crowns the low mound is passed by the casual tourist without a second glance but for the geologist it has a profound significance. The height of the mound indicates a period of growth that can be measured in centuries while the disintegrated condition of the formation would put even the end of its activity in the remote past. Many of the sinter fragments show deposition around a filamentous algal growth quite unlike anything now occurring in the Park and comparable to forms of travertine deposition at Mammoth. These fossil algae, as they may be termed, are covered with sheet-like sinter deposits such as are now characteristic of the basin showing that the algae were extinct before the geysers activity ceased. The old mound in fact is like the ten superimposed cities of Troy and in it the investigator may find traces of every period of the region's development.

Coral Spring, a charming little geyser in its small way, derives its name from a number of boulders that laid in its basin in a loose ring about the vent and which were covered with a peculiar sinter that gave them an appearance not unlike the branching tips of tree-coral. Many of the boulders have since been carried off. Ascending the low ridge the visitors curiosity is aroused by a steady, rhythmic thumping like that of a hydraulic ram. Following the sound he comes upon a gigantic blue-gray paint pot, a true battle-ship gray, that throws its viscous contents into the air every three seconds with monotonous regularity. Less than a hundred yards along the ridge the infrequent visitor comes upon something that calls forth an exclamation of wonder even in this land of surprises. A green cavern arching over a still greener pool that belches forth steam and sulphur fumes from its depths with a repulsive gurgle - surely the "Green Dragon" deserves official sanction to a name that seems inevitable.

Advance beyond this point is difficult and it is well to skirt the hillside above the Gray Lakes. As the visitor nears the upper endof the lakes he encounters Alcove Geyser, a steadily playing spring (for it is not a true geyser, not being periodic) that spurts a fine spray-like jet out of an opening in a niche on the bank. There is practically no sinter deposition and the vent is merely a circular hole in the rhyolite. From this point one obtains a striking panorama of the Gray Lakes with a background of steam columns and playing jets. The lakes are perhaps 200 yards long at their greatest extent; their contour varies greatly with the height of the water-level. The water is gray-green and is in constant motion with weaving and interweaving currents set up by the boiling springs on the lake bottom - a strange, unearthly landscape that would be famous if it were on the loop road. Medusa Spring lies near the south end of

the Gray Lakes on the side toward the highway. The sulphur content of this water is high and the crater and surrounding geyserite are stained chrome yellow. It is an unusual spring and is rendered the more picturesque by its setting - the circular platform of sinter set among scattered groups of pines with a green meadow sloping up the hillside in the background.

A few hundred yards along the edge of the timber brings us to the present loop road and another hundred yards, on the side of the hill, to the old road. Between the two roads in a ravine lies Recess Spring - not to be confused with the so-called "Recess Spring" at the north end of Elk Park. At the right on the mud-flat may be seen the various tributaries of Tantalus heading eastward to their confluence. Along these tributaries just east of the old road are the Orpiment Springs. This group of small mud-holes seems to be the center of concentration of orpiment (arsenic trisulphide) for the Norris Basin. Considerable stretches of sand are colored with it and a spadeful turned up at random drips with the oozy yellow mud - a tint resembling that of sulphur but not distinctive.

The geyserite along this part of Tantalus Creek is worth of close examination; every pebble has grown spines larger than its original bulk and a handfull contains dozens of miniature castles and Gothic cathedrals. As the creek turns northward it passes the Perpetual Spouter, a modest little spring that struggles to substantiate an ambitious name. A quarter mile farther down the stream broadens out into a lake like body of water, the Reservois, a favorite summer resort in the old days.

At this point one obtains his first comprehensive view of the Hundred Spring Plain stretching more than half a mile to the north beyond the reservoir. It is flat as a floor and the sinter sand as white as that of a coral island. The plain steams with a myriad of small vents and here and there spouters play continuously.

Near the lower end of the Reservoir is a spring that is quite unparalleled in the entire park; there is nothing in the park that even remotely resembles it. This is Verma Spring, better known to the old-timers as "Cinder Spring" and perhaps the latter name is preferable. The pool is of great depth, a sounding line going forty feet in several places, and its contents are in a state of constant and violent ebullition which for some unaccountable reason is not confined to the point over the crater but occurs over the entire area of the spring like a gigantic kettle. There is also a periodic action in which the contents surge up at frequent but irregular intervals. The remarkable feature, however, is the coal black "cinders" floating about on the cream colored surface which on examination proved to be tiny hollow spheres, averaging one-eighth inch in diameter, of pyrite and sulphur. Each spherule has a hole in one side and the structure looks as though it had been deposited around a gas bubble although the nature of the process remains a mystery.

Nearby is another spring of great depth (twenty-seven feet) unusual both for its pyrite deposits and the nature of the sinter. Most of the springs in this area are unnamed, an exception being Horseshoe so-called from its shape which is only apparent at low water. Most of the plain drains into the Tantalus Creek; the Realgar Springs in the northwest corner have a separate drainage into Realgar Creek. Although realgar is widely distributed in the Norris Basin it can nowhere be called abundant except at these springs. Here the stream-bed is brilliant with arsenic deposits from the vivid scarlet of realgar (As_2S_2) to the lemon yellow of orpiment (As_2S_3). Swinging eastward we cross that branch of Tantalus Creek that drains the valley below the Frying-pan two miles north and skirt the base of thelow ridge beyond. Rock Spring lies in a rocky gulch on the hillside and the hot water of the pond-like Receptacle washes its banks. Mounting the crest of the ridge at this point we see stretched below us Sieve Lake and beyond the lunch station that marked the beginning of this survey.

While Gibbon Meadows are four miles south of the Norris Geyser Basin a description of the phenomena of that vicinity would appropriately be included in a review of the latter.

High on the side of the mountain (really only an escarpment of the Park plateau) formerly called Mt. Schurz that rises on the far side of the Meadows may be seen the steam columns rising from the Monument Geyser Basin. This rarely visited region is of extreme interest being the highest of all the geyser basins in the Park (7900 feet). It is a long narrow gulch about 150 by 400 feet lying just below the crest of the plateau that forms the top of the "mountain. Scattered

about the area are the remains of perhaps a half dozen old geyser cones like the shattered fragments of idols in a temple garden. The sensations of the visitor on entering this gulch are quite indescribable; it has a far-away, unearthly quality like no other place in the Park. Only one of the cones is still active, a bottle structure about six feet high that plays a fine spray continuously. Near it are deposits of silica in an unusual form having the precise appearance and consistency of library paste in a half hardened condition. At the far end of the basin is a roaring, superheated steam vent that fills with water after rains. Considerable quantities of realgar are present in the run-offs that carry away the water.

On the same side of the Gibbon at the east end of the Meadows are the Sylvan Springs, a long narrow ravine in the altered rhyolite with the opening toward the road. The gulch is literally honey-combed with gas vents and there are numerous springs, several of which are unique. For sheer beauty the "Evening Primrose" would not suffer with comparison with Morning Glory. It is similar in size and form but a brilliant cadmium yellow with touches of crimson at the edges. A continuously playing geyser (six feet), a roaring steam vent and the "Coffin", a gruesome black mud pot, are a few of the points of interest that make this rather inaccessible basin well worth the difficulty entailed in reaching it.

Out in the center of the Meadows a half mile to the east of the river are the remains of several little known geyser cones that are scarcely discernable from the road. Their disintegrated condition, great age, although one steams and rumbles indistinctly from its depths. They are evidently the last vestiges of an extensive thermal area and present a fascinating problem.

To the left of the road as it leaves the Meadows to enter the Gibbon Canyon are the only phenomena in the vicinity that are seen at all by the tourists. These are the Artist Paint Pots at the base of Paint Pot Hill a quarter of a mile back from the road camp. The color here is vivid, a crimson so deep that one can almost imagine them to be pools of blood. These red pots are for the most part very quiet and do not "plop" after the manner of the Mammoth Paint Pots. However, there are a few white pots of the conventional type on the higher bench.

On the east side of Paint Pot Hill in a deep valley that opens out into Gibbon Meadows are the Geyser Springs, a true geyser basin on a small scale that resembles in a way a part of the Shoshone Geyser Basin. There are two active geysers here one of which has evidently broken through the hillside at a comparatively recent date. The crater is so filled with small boulders that the water column is broken into many small jets that force a passage through the interstices. The greatest elevation attained is twenty five feet. The other well marked geyser is of smaller dimensions but shows greater age. There are many springs in this area several of which are of the Punchbowl type.

THE LOWER GEYSER BASIN

By Charles Phillips
1890 - 1927

Unlike the Norris Basin the first impression of the Lower Geyser Basin is unqualifiedly disappointing. In vivid contrast to the concentrated activity of the former the Lower Basin seems dull and uninteresting and altogether lacking in the "pep" we demand these days of our geysers as well as the more personal phases of our daily lives. To the new-comer it scarcely conveys the idea of a basin at all but rather a broad marshy plain with widely scattered clouds of steam hanging over its large vents.

On a frosty morning, however, the steam columns that rise from every minor pool and spring on the basin floor rival those of the largest geysers in midsummer and give a unity of impression to the landscape, "pulling the picture together" as painters say. To those of us who live year 'round with these things, it may be added, the geyser basins appear normal only in winter. There is something fitting and logical in the association of geysers with ice and snow. Perhaps it is a psychological throw back to Iceland that "land of frost and fire".

The writer has noticed a curious but perhaps not unnatural impression on the part of many visitors that the names Upper and Lower Geyser Basins refer to the relative interest and importance of the two regions. Attention might here be called to the fact that the terms "Upper" and "Lower" designate the positions of the two basins on the Firehole River. The early explorers were obliged perforce to describe the thermal regions with reference to the streams on which they were located and thus we read in their reports of the Gibbon Geyser Basin (the present Norris) and the Geyser Basins of the Firehole (the present Lower and Upper). It is interesting to note in this connection that these names have fallen into disuse among the residents of the Park who further simplify the nomenclature by abbreviating Upper Basin to Basin and calling the Lower Basin "Fountain", to the confusion of summer visitors.

For administrative purposes Nez Perce Creek is regarded as the northern boundary of the Lower Basin altho the highway actually enters as it emerges from the Canyon of the Firehole at the road junction in front of the ranger station. The basin may be described as roughly triangular in shape. The Fountain Ranger Station, Twin Buttes and Firehole Lake mark the corners of the triangle and the sides approximate four miles in length. Midway along the southern rim the narrow valley of the Midway Basin (Excelsior Geyser) forms an extension like the tang of an arrowhead. The Firehole River meanders from south to north across the basin floor and Sentinel and Nez Perce Creek, as well as innumerable lesser tributaries, have cut valleys that make yawning gaps in the rim.

The valley of Nez Perce Creek indicates that it was formerly a river of considerable magnitude. The prehistoric stream was one of the outlets of glacial Lake Yellowstone which overflowed over Mary Mt. as well as several other points during the early stages of its existence. The unrelieved flatness of the basin floor suggests to even the casual observer that it is the bed of a lake that once filled the entire valley. While there are no former beach lines apparent on the surrounding slopes the nature of the present lakes indicates that they are the remnants of a former larger body of water. Whether such a lake antedated the glacial Nez Perce river has not been determined but there can scarcely be any doubt that the lake was in existence during the life of the river and that it formed a reservoir for the waters before they plunged down the canyon of the Firehole on their journey seaward.

The recent history of the Lower Basin may be regarded as beginning with James Bridger, undoubtedly the first white man to visit this region, and the early name of Burnt Hole in reference to its extensive tracts of burned timber evidently dates from his description. While W. A. Ferris, an employee of the American Fur Company, was in this part of the Park in 1834, his published account would indicate that he did not see any of the country north of the Upper Basin. The Lower Basin occurs under the name of Burnt Hole on Raynold's map of his explorations of 1859-60 but was probably placed there on the authority of Bridger who was the guide of the expedition. The De Lacy party passed through the Lower Basin in 1863 but had no time to trifle on geysers in their haste to reach the gold fields that had been discovered that year in southwestern Montana.

THE LOWER GEYSER BASIN Phillips

In 1869 a party under Folsom and Cook encountered Nez Perce Creek on their return from Shoshone Lake and saw Fountain Geyser and a number of other phenomena of the locality.

The Washburn-Doane expedition of 1870 was the first to establish the position of the basin and to comprehend the significance of what they saw. However, the low state of their rations and their desire to institute a search for T. C. Everts who had become lost while the party was south of Yellowstone Lake, made their stay a brief one and prevented an adequate survey of the region. This was accomplished the following year by Dr. F. V. Hayden's party, the first scientific expedition in the Park, who gave the Lower Basin a thorough examination, more so, in fact, than they intended for they were first under the impression that it was the Upper Basin.

The Nez Perce Indians with Gen. Howard's troops in pursuit passed through this basin on their celebrated tour of 1877. The Indians' route was up the Firehole from Madison Junction to the mouth of Nez Perce Creek and up the latter stream to Mary. Mt., thence across Hayden Valley along Elk Antler Creek to the Yellowstone River. It was in the Lower Basin that they encountered the Cowan party whose adventures are an interesting episode of the Nez Perce War. The Radersburg tourists were encamped near the Fountain Geyser when the Indians found them; from there they were taken up Nez Perce Creek at the head of which their unfortunate experience occurred.

It was during the stage-coach days that the Lower Basin enjoyed its greatest prestige. The Park tour was then five and one half days, the additional day being spent at the Fountain Hotel. With the introduction of auto-busses in 1917 the run from Mammoth to Old Faithful was reduced from a day and a half to half a day, giving the tourist more time at the Upper Basin but cutting down the halts at Norris and the Lower Basin to less than a half hour. When the Fountain Hotel was an overnight stop both hiking and carriage parties were conducted over the "formations". With the abandonment of the hotel the basin lost favor with the public and today its visitors are largely those auto tourists who are determined to see everything in the Park even though they do have to camp on a site where the water isn't piped and the wood cut ready for use.

Part of the neglect of the Lower Basin is due to the lack of suitable facilities for visiting the outlying portions. The points of interest are so widely scattered that it is a problem to construct a road that will pass all of them. Several of the earlier roads made some attempt to do this but found it impossible to visit the phenomena on both sides of the valley without doubling back. The present road cut the Gordian knot by going in a straight line down the middle of the basin but by so doing missed everything of interest except Fountain Geyser and that is now practically dormant.

In the absence of any organized guide parties or nature trails we may describe the points of interest in the order a tourist traveling in the normal counter-clockwise direction would encounter them. Emerging from the timber in front of the Fountain Ranger Station he finds a large part of the basin spread out before him. To the southwest rise Twin Buttes (one is hidden behind the other from this point) whose alignment once determined always gives the traveler his position in the valley. Across the freight-road bridge may be seen the remains of an early hotel, antedating the Fountain Hotel (1891), that was used when the route to the Lake went up Nez Perce Creek. The various hot pools in the vicinity served as laundry, bath house, etc.

Half a mile farther up the road crosses Nez Perce Creek. This locality is of considerable interest from an historical standpoint. The first road to Lake and Canyon via Nez Perce Creek branched off at this point and made the junction the strategic center of the basin; in later days it was rebuilt on the south side of porcupine Hill. There was a large cavalry camp here every summer and the old guard-house (often called"block house") is still standing. Porcupine Hill, known as East Fork Butte in the early days, offers a wonderful panorama of the entire basin and the Nez Perce Creek Valley and made a useful fire look-out for the soldiers encamped below. On the slopes beyond Porcupine Hill are the Morning Mist Springs, a large area covered with small vents whose combined steam cloud on a frosty morning hangs along the hillside like a cloud on a mountain. Still farther up the Nez Perce valley on the same (south) side is the Culex Basin, an amphitheatre-like opening in the mountain side whose sides and floor are perforated with small vents.

THE LOWER GEYSER BASIN Phillips

Passing Porcupine Hill the old Fountain Hotel comes into view a mile ahead. The hillside to the left and the interesting meadow contain fifty or more springs having little intrinsic interest but whose proximity to the hotel formerly made them objects of considerable attention. They may be regarded as comprising two groups. The nearer, known collectively as the Quagmire group, is in a marshy tract that prevents close examination altho they would scarcely merit it even if they were accessible. One, a small sinter cone, emits a peculiar sound that has earned it the inelegant name of Snort.

Immediately behind the hotel is a group of attractive springs much visited in ante-bus days. Their names, Oak Leaf, Kidney, Jug, Gourd, Stirrup, etc., indicate a fancied resemblance to the objects named. Fungoid is a better choice for the masses of sinter on the rim are not unlike huge fungus growths. The chief object of interest here is Thud Spring, a large deep pool that at intervals of a few minutes gives out a thumping sound that shakes the ground in its vicinity. This is undoubtedly due to a periodic accumulation of steam in some subterranean cavity. Several hundred feet to the east a high mound is Lone Spring.

On the Sinter Plain directly across the road from the hotel are several large springs of unusual beauty. The intense blue of one has won it the name of Gentian Spring; another, the Kaleidoscope, has a slight periodic action that produces a play of colors suggesting that nearly forgotten toy.

A quarter mile in front of the hotel the sinter plain slopes up to a conspicuous white hill. On top of this elevation and on the sky line in full view of the hotel is one of the most famous geysers of the Park, the Fountain, that gives its name both to the hotel and to that type of geyser of which it is a characteristic example. The crater consists of two large connected pools the lesser of which is the true vent. The large size of the tube prevented the eruptions from attaining a height greater than 60 to 75 feet. However, its frequency in the old days (the intervals were two to four hours) and the vast quantities of water thrown out made it a remarkable spectacle. Of late years it has become exceedingly irregular and often a season passes without a single eruption.

Fountain Terrace is perforated by innumerable vents, many of them small geysers, that received names and much attention in the hotel days but are regarded with scant interest by tourists today. Jet is well named and is in frequent eruption. Bellefontaine is equally frequent but scarcely sustains its title of "beautiful fountain". Jelly was so called on account of its deposits of viandite, a gelatinous form of geyserite. Clepsydra, named from its fancied regularity for the ancient water-clock of the Greeks, has of late years developed into a geyser of considerable power. Its eruptions are by no means as frequent as formerly but the increase in magnitude more than compensates for any loss in this direction. There is a striking parallel between the rise in power of Clepsydra and the decline of Fountain that suggests an inter-relation. A hundred yards to the east beside the road is the White Sulphur Spring (formerly "Leather Pool") that once supplied the water for the geyser baths of the hotel.

Across the road which describes a semi-circle around them, are the Mammoth Paint Pots. These are without doubt the most attractive examples of this widespread phenomenon in the Park altho they are surpassed in delicacy of color by the Artist Paint Pots (Gibbon Meadows) and those at the Thumb, and in size by those on Mt. Washburn (Devil's Ink Pot). Their contents is almost pure kaolin, a decomposition product of rhyolite and the basis of potter's clay. The color is due to the oxide of iron, pure white where the oxides are lacking through deepening shades of pink, where they are present in varying quantities, to rose red. Many tourists are held here for hours spell bound by the uncanny humor of the place; others are equally fascinated by the constantly appearing and disappearing figures on the surface of the clay-like lilies and roses in bas-relief.

At the foot of the slope north of the Paint Pots and across from Silex Pool a side road branches off sharply to the left. This road has fallen somewhat into disrepair of late years but is scheduled for early reconstruction. A mile from the junction is Hot Lake, the largest body of water at its temperature in the Park. Clouds of steam roll off its surface on the warmest days of summer and there is a troubled, haunted feeling about the place that suggests the underworld of some ancient legend. At the farther end is the largest constantly erupting geyser in the Park, a double jet playing 20 to 40 feet whose unceasing activity conveys a tremendous impression of the earth forces below. It was for years known as Steady Geyser but has been more recently rechristened Black Warrior.

THE LOWER GEYSER BASIN Phillips

Firehole Lake, a neighboring body of water at the head of the valley, is one of the most famous phenomena of the Yellowstone. It is true that it has a "human interest appeal" that holds many who are unmoved by more impressive spectacles. Even the sage-brusher who can't recall a week later whether or not he saw the Canyon always remembers the flames under the water. They are at the upper end of the lake and of course are nothing more than a stream of gas and steam bubbles emerging from a vent on the bottom. However, the resemblance to the blue flame of a bunsen burner is perfect and the illusion is intensified by the black background. To be seen properly they must be viewed by a strong back or cross light; a platform at the proper point would enable many to see them who now go away disappointed. Sulfosel, Zomar and Young Hopeful are other springs in the vicinity; the last named is a small geyser.

Formerly a rough road led from Hot Lake to Great Fountain, a little less than a mile to the southwest, but changes of drainage have so effaced it that a trip in an automobile is somewhat hazardous unless one is familiar with the ground. A number of small but interesting springs lie along the west side of the old road. Bead Geyser is a small geyser with a beaded rim. The cone of Pink Cone Geyser is a beautiful shell pink, the largest formation of pink sinter in the Park. Narcissus Spring on the neighboring hillside is a pool of wonderful depth and clarity. At the left of the road is Bath Lake with the wreckage of the former bath-house on the far side.

A quarter mile ahead may be seen the White Dome although the road does not pass near it. This huge white cone, standing 25 feet above its base, is a conspicuous object on the flat, treeless plain and is the only cone in the Lower Basin that may be compared to the huge masses of formation found in the Upper Basin. It spurts at intervals of an hour or less to a height of ten feet but the diameter of the former opening and the size of the cone indicate that it was once a powerful geyser.

The road has now reached its objective, Great Fountain Geyser, the largest geyser in the Lower Basin and one of the five major geysers of the Park. It is interesting to note that it is the only geyser of the first magnitude that is situated at any great distance from the Firehole; all the others are within a few hundred yards of the river, but Great Fountain is nearly two miles from it. It is unfortunate that this wonderful geyser is not more often seen by tourists. Its eruptions bear some resemblance to those of Grand but much more water is ejected and the general impression is one of far greater power. There is no single jet that attains a great elevation but the effect is that of a great fountain with a thousand jets whirling and interlacing in every direction. The broad base on which it is situated and the symmetry of the play of the water produce an effect that is almost architectural. Its interval is somewhat irregular but it may be depended on to play at least once in twenty-four hours. Like all "fountain" geysers, the eruption consists of successive spurts, the entire display lasting over an hour.

Immediately south of Great Fountain is a low elevation covered with sinter sand that serves the spectators as a point of vantage from which to view the eruptions. On top of this mound is Surprise Spring, a large pool of inky-green water that surges in sudden ebullition if a handful of sand is thrown into it. This phenomenon, the boiling around any cold object inserted in it, is common to all super-heated water but seldom responds with dramatic effect displayed here. A foot- trail leads up the ravine in a southwesterly direction past several points of interest. The Diamond is a handsome diamond-shaped pool of deepest green. The Five Sisters are small pools of various sizes and colors connected by channels. At the head of the ravine is Buffalo Pool (not to be confused with Buffalo Spring) on whose bottom may be seen a number of whitened bones but the constant agitation of the surface makes it impossible to see them distinctly enough to identify.

At Great Fountain the side road turns west again to join the grand loop but with the exception of two springs within the first hundred yards there is nothing of interest in it. These are Firehole Pool in which a flame like that of Firehole Lake may be sometimes observed, and Egg-shell Spring that resembles a huge egg two-thirds buried in the earth and with the upper end broken off. The main road is entered again about a mile west of Great Fountain.

The points of interest in the western half of the Lower Basin may be seen from

the Fountain freight road or by short side trips from it, altho to explore the area thoroughly necessitates more extended trips up Sentinel and Fancy Creeks. The point at which the freight road diverges from the loop road is in front of the Fountain Ranger Station from where it continues in a direction nearly due south until it encounters the main road again above the Excelsior Geyser Basin. The first mile between the junction and the crossing of the Firehole is devoid of interest but at the bridge it touches on the north end of the largest thermal area in the basin known collectively as the River Group.

This group lines both banks for a mile to the southward and extends back from the river a half mile at points on the east side. It is at present difficult of access on account of its boggy environment but the nature of the phenomena warrant a future foot trail in this area that would extend perhaps a half mile down the east bank, cross on a foot bridge and return to the freight road along the west bank.

Approaching the bridge a large and extremely hot spring, Ojo Caliento, is seen on the down-stream side. Continuing up the east side above the bridge we presently turn into Pocket Basin, a broad shallow depression opening toward the river and containing innumerable pools and springs, many of exceptional interest. Between Pocket Basin and Rush Lake (the "Goose Lake" of early writers) are the Mud Volcanoes, one of the largest groups of paint pots and volcanoes altho virtually unknown at present. There are perhaps half a hundred in all, several of which are thirty feet in diameter.

Returning to the river we find the bank lined with many springs of an unusual nature. It is possible to mention only a few as the majority are unnamed. Horn Spring and Cove Spring are high conical structures (like the chocolate pots but lacking their color) that rise from the waters edge. A peculiar type of spring is frequent here that occurs within the river itself along the shore; walls of sinter segregate the water of the spring from that of the river. Conch Spring is undoubtedly the handsomest pool in the vicinity, a periodic spring 18 feet in diameter with its rim scalloped like a huge sea shell.

Returning to the bridge and ascending the west side of the river a hundred yards above the rapids the visitor comes upon several large and extraordinarily deep pools with edges that overhang so far he feels himself in a somewhat precarious position as he peers into their intensely blue depths. One of them is the famous Buffalo Spring; its bottom is strewn with bones that as far as can be ascertained through that depth of water are those of a buffalo. Few of the springs here are named and all resemble those on the opposite bank making a description unnecessary.

Just around the big bend in the Firehole beyond the bridge Sentinel Creek enters the river. A trip a mile up the creek reveals one of the most interesting parts of the Lower Basin called the Queen's Laundry for some unknown reason. On entering the valley from below the traveler sees before him four large mounds running in a row diagonally across it. The middle two are the largest and stand like sentinels on either side of the creek that flows between them, suggesting the stream's name. This valley was evidently the scene of much thermal activity in ages past and these isolated mounds are the monuments of once powerful geysers.

The banks of Fairy Creek which flows into the Firehole between the bridge and the mouth of the Sentinel Creek, are covered with a vast number of springs and vents but the only one that is of more than passing interest is Spray Geyser at the very head of the valley south of Twin Buttes. The noteworthy feature of this geyser is its isolated position. The eruption is largely steam and the little water ejected is broken into spray by the nature of the vent. Its steam column, however, is a conspicuous object from those points of the basin from which it is visible. Mention should be made of the attractive small lakes lying in the amphitheatre between the two buttes. They were formerly known as Crater Lakes for the amphitheatre at close hand bears a striking resemblance to the crater of an ancient volcano, with a broken down and shattered rim.

As before stated the freight road effects a junction with the main road above the Excelsior Geyser Basin. This area, also called the Middle Geyser Basin, is half way between the Lower and Upper Geyser Basins and is often regarded as a distinct geyser region. Topographically it is in the valley of the Lower Basin, the canyon which separates the latter from the Upper Basin beginning just above the road junction.

THE LOWER GEYSER BASIN Phillips

Whether Excelsior Geyser is a geyser or hot spring remains a debatable question. During the period in which it was known to be active (1878 to 1888) there was little doubt as to its nature for at that time it was the largest geyser in the world and probably has never been exceeded for both height and volume. It was most active in the winter of 1881-82 and again in 1888. In the latter year it hurled a column of water 50 feet in diameter to an elevation of 300 feet. The nature of its eruptions would indicate that it was never a typical geyser with a definite relation between pressure and boiling point but rather an enormous spring whose tube became clogged with rocks and other debris from time to time and that the accumulated steam ejected them by a veritable explosion. The same phenomenon has occurred in recent years on a smaller scale, notably the semi-centennial geyser in 1922. Apparently the force of its last eruption in 1888 so enlarged the vent that further eruptive activity is impossible but he would be a rash prophet who would undertake to foretell the Excelsior's future conduct.

On the farther side of Excelsior from the direction in which the latter is usually approached lies Turquoise Spring, perhaps the most appropriately titled of all the pools designated by the names of precious stones, Sapphire, Emerald, Topaz, Beryl, Opal, etc. It is about 100 feet in diameter and its color reproduces precisely the veiled, yet brilliant blue of that gem. The cloudiness is due to suspended mineral matter in the water for the contents of the pool are largely the run off of Prismatic Lake whose waters overflow the surrounding sinter in a thin sheet and drain into the depression carrying with them quantities of sediment in suspension.

While the pastel shades of the terraces at Mammoth Hot Springs may surpass Prismatic Lake in the subtelty of their tints, nothing in the Park approaches it for either brilliance or breadth of coloration. It is truly prismatic for it has all the colors of the rainbow save violet; the water itself supplies the blue and the algae the yellow and red. The color scale runs from deep blue in the center of the lake through green in the shallow water to pure yellow at the rim; outside the rim the yellow shades through orange to crimson. Unfortunately the steam that rolls off the surface obscures the view of the visitor standing at the shore. The best view is obtained from Bluff Point across the river; in fact, the panorama of the entire basin from that point would justify the construction of a foot-trail to it. But the view from any point by day pales into insignificance beside that at twilight. Then the colors both of the depths and of the rim deepen to an inconceivable richness and the saffron-pink they cast on the waving steam clouds at sunset inevitably recalls the "Magic Fire Spell" to those who have seen Wagner's "Valkyrie".

THE UPPER GEYSER BASIN

By Charles Phillips
1890 - 1927

To the average tourist the Norris and Lower Basins are mere preliminaries to the Upper Geyser Basin. That this should be the case is perhaps regrettable but it can scarcely be gainsaid that for spectacular qualities the Upper Basin excels all the other thermal regions of the Park combined. Here within the limits of a mile are five of the six major geysers of the Park, Giant, Grand, Beehive, Giantess and Old Faithful, while there are as many of lesser magnitude that are equally well known for other reasons, Riverside, Grotto, Castle, Daisy and the Lions.

While this thermal area is not as compact as Norris its phenomena are much more concentrated than in the Lower Basin. The Upper Basin, exclusive of the Lone Star extension, the so-called "Third Geyser Basin of the Firehole", may be regarded as ambracing an area three miles in length by a mile and a half in width. It lies in an approximate northwest - southwest direction and comprises the combined valleys of the Firehole River and its tributary Iron Creek that flow parallel for some distance and then rather suddenly converge at a point about three miles up the Firehole from Excelsior Geyser. The upper two miles of this interval lie within a narrow canyon and being devoid of thermal activity, with the exception of minor springs along the river's edge, form a definite tho narrow zone of demarcation between the two basins.

Of the three geyser basins along the loop road this one lies nearest the Continental Divide altho it is a few miles farther from the "hump" than the Shoshone and Heart Lake Basins. The continental water-shed swings around the entire Upper Basin in a semi-circle that would measure perhaps a dozen miles in diameter if the numerous bends and jogs were averaged together, and approaches within four miles of Old Faithful at two points. In elevation it lies between the 7300 and 7400 foot levels and in spite of its proximity to the back-bone of the continent, is lower than all the other geyser areas except the Lower Basin which lies a hundred feet below it.

Like the depressions in which most of the thermal regions of the Park occur, the Upper Basin is the result of excessive erosion due to the disintegrated nature of the rhyolite through the action of the steam and gases from below. Here the gases and steam have broken through at a point where several streams came together (the Firehole, Iron Creek and Little Firehole) and the decomposition of the rocks of the intervening spurs permitted the surface drainage to wear them down to low ridges that appear as mere irregularities on the basin floor. The canyon of the Firehole at the points where the rhyolite is unaltered by thermal action is a narrow gorge bearing evidence that it is geologically recent. Glacial drift is noticeably meagre in this area, in striking contrast to the broad stretches of ice-carried material that are characteristic of the Lower Basin.

While the Upper Basin was visited and described nearly a century ago it was for the most part far less known to early trappers than the Lower. This was largely due to the fact that the trail across the Park left the Firehole at Nez Perce Creek and followed that stream to Mary Mt. from whence it corssed Hayden Valley to the ford of the Yellowstone at the Mud Volcano. There is no evidence whether or not Bridger was familiar with this Basin. There is some negative evidence that he was not in the form of the map of the Raynold's expedition (Bridger was guide of the party and was evidently consulted in the preparation of the map) on which the Lower Basin appears under the name of Burnt Hole while there is no indication at all of a basin farther up the Firehole.

The first indubitable proof of the presence of a white man in this region was the publication in a now forgotten journal of an account of a visit in 1834 by W. A. Ferris, a clerk of the American Fur Company, whose description of what he saw makes it impossible to doubt that the phenomena he observed were those of the Upper Basin. In spite of the not infrequent presence of trappers in the Park area there are no records of the Upper Basin having been visited for the next thirty five years and three exploring parties passed within a day's travel of it without knowledge of its existence.

The previously mentioned Raynold's expedition of 1859-60 was prevented from entering the Park plateau by the great depth of snow that still lay in the passes in June of the latter year. Their route along the west side of the Yellowstone country was up the North Fork of the Snake River to Henry Lake. De Lacy's party

(1863) came up from Shoshone Lake along the creek that now bears his name and dropped down from the Continental divide by way of the little warm creek that flows into the Lower Basin near the Great Fountain Geyser. Their line of march took them within sight of Mallard Lake and within five miles of Old Faithful. The route of Folsom and Cook in 1869 was also up De Lacy Creek but on reaching its head they took a more northerly direction and descended into the Nez Perce valley through the heavy timber between the Lower Basin and Juniper Creek, encountering Nez Perce Creek three or four miles above the present bridge.

The discovery of the Upper Basin in the true sense of the word may be said to date from 1870 when the Washburn-Doane expedition whose explorations in the Yellowstone country took the region out of the realm of legend and placed it on a basis of established fact, passed through the area in the early autumn of that year. The party had thoroughly explored the east side of the Park and concluding that they had seen as much and even more than the vague rumors of the region had reported to exist there, left the Thumb for the headwaters of the Madison by which route they intended to return to Fort Ellis near Bozeman. Their line of travel followed in a general way the Continental Divide road altho they did not encounter the Firehole River until they came to Kepler Cascade. From here they descended the river along the east bank, crossing to the other side immediately in the rear of Old Faithful Camp. Quite unconscious of what lay before them they made their way through the broken timber between the river and the present road and as they emerged into the open valley of the basin at a point not far from where the recreation building of the Camp now stands, the water column of Old Faithful rose in full eruption before their astonished eyes. In spite of a shortage of rations the party spent the greater part of two days in the basin during which time they saw seven geysers in action and the names they gave them remain unchanged to the present day, Old Faithful, Giant, Giantess, Beehive, Castle, Grotto and Fan.

During the following decade this part of the Park was visited by numerous expeditions and exploring parties. Among the more notable were the Hayden Surveys of 1871, 1872 and 1878; the Jones expedition of 1873; the Ludlow expedition of 1875; the party of Gen. Belknap, Secretary of War, in the same year; Gen. Wm. T. Sherman in 1877; and Carl Schurz, Secretary of the Interior, in 1880. Col. Norris, the second superintendent of the Park built a road from Mammoth Hot Springs to the Upper Basin in 1878, making the principal geyser basins accessible to the traveling public. This road entered the Upper Basin on the site of the present road but at Biscuit Basin it turned to the right and followed the river closely to Riverside Geyser where it ended. The side road to Morning Glory Spring is part of the Norris road and the old right-of-way, altho almost obliterated by second growth, can still be traced between Sentinel and Artemisia Geysers.

For many years the road to the Lake and Canyon followed the former trail up Nez Perce Creek and the only hotel was Marshall's in the Lower Basin. In those days the Upper Basin was a side trip from which visitors returned to the Lower Basin to continue their journey to the east side of the Park. In 1886 a hotel was built in the Upper Basin by Herbert which became an overnight stop for the recently established stage line. The present road over the Continental Divide was opened in 1891, marking the inception of the present "loop trip". In 1904 the earlier hotel was replaced by Old Faithful Inn, at that time the largest log structure in the world and the proto-type of rustic architecture on a large scale. The four-horse stages were supplanted in 1917 by motor-busses and the more rapid transportation afforded travelers a full twenty-four hour stop in this basin.

The visitor entering the basin from the north (the only direction from which it may be approached as the Park regulations prohibit traffic on the Continental Divide road from the Thumb to Old Faithful) notes a rather abrupt widening of the canyon to a point three miles above Excelsior Geyser where the Firehole valley is joined by the valley of Iron Creek from the southwest, the lesser one of the Little Firehole from the west and the still smaller one of the Coldstream Brook from the northwest. The broad valley at the convergence of the four streams is an extensive sinter plain much of the original deposit of which is now covered with a thin soil that supports a sparse growth of lodge pole pine. The most active part of the plain is at the junction of Iron Creek and the Firehole River and is known as Biscuit Basin from a characteristic form of the sinter in several of its pools. It is reached by a branch of the loop road that permits cars to be driven to the bank of the Firehole where a foot-bridge crosses to the basin on the other side.

THE UPPER GEYSER BASIN Phillips

As the visitor ascends the slope between the run-off channels of Sapphire Pool he observes on his right a huge cavity in the sinter with fractured walls that bear witness of the power of the subterranean explosion that opened it up in the spring of 1925. Sapphire Pool is an excellent example of the intermediate stage between a geyser and hot spring, sometimes called "geyser springs" by way of compromise. It boils up violently and overflows every two or three minutes but there is no jet and the only movement of the water is the surging caused by the violence of the ebbulition. Between periods there is a short interval of calm during which the deep but transparent blue of the water can be observed. The "biscuit" structure of the sinter is very conspicuous here.

Above Sapphire Pool is the chief geyser of the area. It was originally called Soda Geyser by the topographer of one of the Hayden Surveys who fancied a resemblance to the jet of a soda fountain, but has been renamed Jewel Geyser in reference to the beaded and jeweled geyserite about the vent. It plays a single sudden spurt to a height of twelve or fifteen feet at five to ten minute intervals. Nearby is Silver Globe for whose name two equally appropriate explanations have been offered, the large bubbles of gas (CO_2) that are constantly ascending from its depths and the globular, silver-gray masses of sinter in the crater. In the scattered pines still farther up the slope is the periodic spring first called Avoca but now bearing the name "Mustard". It is remarkable for the sinter covered stump that lies in the crater. The deposit is evidently several inches in thickness and the general appearance is quite similar to that on the logs around Rustic Geyser at Heart Lake. The springs and geysers just described lie in an irregular row back from the river. North of them is a group of small geysers several of which are named, the original Mustard for its greenish-yellow deposit, Pearl for its beaded sinter, Shell for its pearly lining, etc.

As the Biscuit Basin side road rejoins the main highway it passes two interesting pools, Biscuit and Mirror. The first is a "geyser spring" that boils up at irregular intervals; it exhibits on a small scale the type of sinter that occurs so extensively about Sapphire Pool. Mirror is a large quiet spring with no distinctive features worthy of comment; its overflow sustains a growth of algae that is more conspicuous than the spring itself. On the right at the top of the long grade are three more pools that form a triangular group. The first, Sprite, would be passed unnoticed if it was not practically under the wheels of passing cars. The second, Gem, is far more attractive and is dignified by a tiny side road that touches its brink. Calthos, the largest of the three, is at some distance from the road on the top of a self-built mound that is more conspicuous at a distance that it is as the road passes it. Below the mound on the high bank of the river is a large spring that the writer has seen at infrequent intervals playing as a geyser of considerable power altho the size of the vents prevents any great elevation.

The road asconds still another grade and just before it turns sharply to the left at Old Faithful View passes two interesting geysers and several springs. The springs in this vicinity are strongly impregnated with iron oxides and the group at the left of the road is known collectively as Iron Springs. However, the most vivid is on the right and a few feet below the road level. It once bore the name of Bench Spring but the stage-drivers sobriquet of "Tomato Soup Spring" is so thoroughly descriptive that that virtue outweighs the obvious shortcomings of the name. It is the most brilliant pool of the Upper Basin and bears comparison to the Artist's Paint Pots. As they are very conspicuous from this point attention may be called to the Hillside Springs, a group of iron springs on the slope below the Madison Plateau on the far side of the valley. They are between one and two hundred feet above the level of Iron Creek and extend as far up that stream as the mouth of the Yellowbell Brook. They were called "Iron Springs" by the Hayden Surveys and the stream below "Iron Spring Creek" which latter name has been since curtailed to Iron Creek. The steam from Asta, the largest of the group, is very much in evidence on a cool day even tho it is a mile away.

Below "Tomato Soup Spring" and about twenty-five feet beneath the road level is a really notable geyser that suffers unjustified neglect on account of its inconspicuous and inaccessiblity from the highway. This is Astemisia Geyser, evidently so-called for the vigorous growth of sage brush (artemisia) in its neighborhood or possibly for the sage-like color and texture of the formation. Its crater is one of the largest of the active geysers in the Yellowstone and the blue of its depths together with the pearly green sinter that in color and pattern is quite any other in the Park, renders it wonderfully attractive. Its eruptions are in the nature of gigantic upheavals of the contents of the crater

altho the jets occasionally reach fifty feet or more. The volume of water thrown out is enormous. Its interval is unknown and is evidently irregular, but the writer's observations would lead him to put it between one and three days Between Artemisia and the river is a pair of small cones one of which, Restless, is an irregular and apparently infrequent geyser. Its eruptions are like those of a miniature Beehive and the slender jet reaches a height of thirty-five feet.

From this point to Riverside Bridge there is nothing to be seen along the main road, the thermal activity being entirely along the "Morning Glory loop" that turns off to the right at the bottom of the hill below "Old Faithful View". As this side road approaches the river it passes Sentinel Geyser. This title should properly be plural for the name was given to the small geyser on the opposite side of the Firehole as well, the two being conceived as sentinels standing guard over the river that flows between them. The nearer sentinel is more active than its partner and would be a noticeable object if the noise of it were not drowned out by the roar of the nearby cascades.

A hundred yards farther the road passes Morning Glory which has become the most famous of a large class of springs and deservedly so, for it is without doubt the most symmetrical and delicately colored of all those on the loop road. It is, however, surpassed in both respects by several unnamed springs in the more untraveled portions of the Park. In this type the narrow tube of the spring flares out like the bell of a trumpet at the surface of the ground and in the shallow water of the rim the temperature is low enough to foster the growth of yellow and orange algae that blend into the blue of the center whose purity depends on the whiteness of the kaolin lining.

Between the road and the river are two small geysers both of which have seen better days. Fan was regarded by the early explorers as a remarkable geyser and they gave it much attention at the expense of the neighboring Riverside. Its fan shaped eruptions are now infrequent and of much less magnitude. The nearby Mortar was described by the Hayden parties as being sympathetic with Fan but eruptions of the latter are so infrequent that verification is difficult today. Most of Mortar's activity is along the fissure on the river side of the formation but occasionally its main crater, which resembles a huge pharamcist's mortar, fills and throws jets violently in all directions.

The phenomena so far discussed are only a prologue to the basin proper, which the road now enters, as it crosses to the west side of the Firehole River. Riverside Geyser just above the bridge on the east bank may be regarded as marking the lower limit of the basin proper. Altho the beauty of its setting is somewhat marred by a very prosaic sand-pit in the background Riverside is without doubt the most attractive pictorially of all the geysers in the Park. Its appeal is wholly romantic and the sense of awe and wonder that is so prevalent in the thermal regions here gives place to one of esthetic pleasure. It is unfortunate that so many visitors see it and photograph it from a point directly across the river; the effect is much finer from the slope above the sand-pit road where the span of its arching jet over the Firehole stands out against a setting of dark pines with the winding river in the foreground. Riverside enjoys the further distinction of being one of the most regular, both winter and summer, of all the Yellowstone geysers. Every seven or eight hours it announces the forthcoming eruption by over-flowing from the lower vent. Then after a few introductory spurts the jet leaps to a height that reaches sixty feet for a minute and gradually subsiding, is followed ten minutes later by a vigorous steam period.

Across the river on the right side of the road is an area of several acres that is the scene of much activity on a small scale. There are several diminutive geysers here with infrequent periods but the only feature that need delay the traveler are the Chain Lakes. This is a unique series of deep springs connected by narrow channels, the whole evidently occupying a fissure in the underlying rhyolite. The one nearest the road is the Bottomless Pit, of the early explorers. Over the adjacent ridge ("Wylie Hill") is Cyclops, a magnificent spring about sixty feet in diameter and of great depth, that would be famous if it were on the main road. On the left side of the highway is the Spa, named after a type of mineral spring in central Europe. This Spa, needless to add, lacks the curative powers of its namesake. It is a semi-geyser and surges up and overflows at irregular intervals. The writer's observations lead to a conclusion that there is some relation between it and Grotto altho the activity of the two is not always simultaneous.

THE UPPER GEYSER BASIN Phillips

A hundred yards up the road is a pair of geysers so intimately associated that they are always mentioned in the same breath, "Grotto and Rocket". Grotto, however, claims the lions share of the attention both for its cavernous crater in repose and its tumultuous activity in eruption. Ordinarily neither geyser reaches an elevation of more than ten or fifteen feet, but several times a year the Grotto will suddenly cease playing and Rocket sends up a column that may reach a hundred feet for a few minutes. This is perhaps the rarest of all the normal phenomena of the Upper Basin and to see Rocket play is the finishing touch of a thorough acquaintance with the geysers. The interval of Grotto and Rocket is extremely erratic but they are in eruption at least twelve hours out of twenty four in periods of one to three hours at a time. During their activity several springs near the river drain completely and in one of the run-off channels is a vent apparently once a geyser that now acts as a drain and into which much of the overflow of the geysers above pours with a sound like rain water on a city street going into a man hole.

It has been suggested that the cylindrical protuberance in the center of Grotto is a sinter covered log. If that is true it must have been placed there through human agency for no tree could grow near enough the vent to fall into it naturally even if the steam pressure allowed it to remain. In any case, if it is a log it has been in its present position from a remote period for the diameter of the projection is several times that of the trees that grow in the vicinity and it would require many centuries to coat it to that thickness with geyserite.

At this point the Black Sand Basin road diverges to the right. As it is not usually traversed until the basin proper has been covered it will not be discussed until after the phenomena along the Firehole have been described.

About five hundred feet farther up the Firehole but much nearer the river is Giant Geyser. This is the largest geyser not only in Yellowstone Park but in the world. For a few minutes at the beginning of an eruption its water column cometimes attains an elevation of two hundred and fifty feet which is approximately twice the height of Old Faithful. It is true that this elevation has been greatly exceeded by the Waimangu Geyser of New Zealand; the latter, however, was apparently not a true geyser but a volcanic vent throwing black mud and its activity was only temporary.

In discussing the period we come upon a problem that is perplexing to the student of thermal activity, namely, the discrepency between the emphatic and oft repeated statements of geologists who have spent much time in the Park that the geysers have not diminished appreciably during the period of their observations, and the published geyser tables that appear in various guides and handbooks, both official and otherwise, in which the periods given for most of the larger geysers are mere fractions of the present intervals. In the case of Giant the period usually given is six to fourteen days, yet in the available records the writer can find only a few instances of eruptions occuring so frequently and in no case consecutive eruptions at that interval. During the two years in which he has had the Giant under surveillance the average interval has been 91 days with a maximum of 107 days and a minimum of 52 days.

It is interesting in this connection to note that none of the early expeditions observed as frequent activity as six to fourteen days. The Hayden Surveys of 1871, 1872 and 1878 did not see it at all, neither did the Jones expedition of 1873 or the Ludlow expedition of 1875 altho several of these parties were in its vicinity long enough to see an eruption if they had been as frequent as the interval given above. Dr. Peale of the Hayden Surveys in his final report of 1883 states definitely that it is "rarely seen in action" and that its "period is evidently a long one". If, however, there has been any diminution in power of the larger geysers in late years, it is probably only a periodic variation as a sudden "final tapering off" would be most unlikely after the countless centuries of activity which the rocks reveal.

On the same mound with Giant are two small geysers, Mastiff and Bijou (first called Young Faithful); the former is a opening in the sinter and the latter is a cone with several openings the lowest of which acts independently of the others and was at one time known as Catfish. Both Bijou and Mastiff play frequently altho without much regularity, and one of the two is usually in action at all times. All the openings about Giant are very active at irregular intervals, especially just preceding an eruption and eject steam and small jets of

There are two vents, one within the crater and the other just outside the rim. The latter is sometimes called the indicator for Grand but both it and the vent in the crater sometimes play alone. It is true, however, that both vents are especially active before and during eruptions of Grand and often continue playing after the larger geyser has ceased. The crater of Turban geyser bears a sign "Burning Pool", but the underwater "flames" are difficult to see on account of the light background and the agitation of the water. There has been a tendency recently to apply the name of Burning Pool to Turban proper and call the jet in the rim(the "Indicator") Turban Geyser.

The Triplets nearby are three vents of the most dissimilar appearance that always act together. One is a symmetrical funnel of geyserite, another a fissure in the rhyolite and the third a mere hole in the sand. They lie in the arc of a curve that if extended would pass near Grand and Turban which suggests that they are all on the same fissure. They are, however, only slightly affected by their large neighbors. Activity of the Triplets is heralded by a vague subterranean thumping that seems to come from a point about 20 feet from the sinter vent on the river side. This overflows and there is a brief eruption that reaches a height of 10 feet. The other triplets follow suit but their activity is confined to a vigorous boiling. Near the middle Triplet is a quiet little steam vent in a bed of dry sand that on rare intervals fills with boiling water while the sandy bottom and the cracks in the surrounding rocks seethe and hiss like a "Frying Pan".

A narrow fringe of trees separates the Grand sub-group from the Sawmill subgroup, an extensive area of springs and small geysers that do not have any apparent connection with each other. The trail first passes the low cone of a small and infrequent geyser, now called Tardy but named Bulgar by the Hayden party. Next is Spasmodic, a miscellaneous collection of vents around two large craters, which, when the entire assembly is in action, does credit to its name. The small cone beside it is the Handsaw that once or twice a day emulates the nearby Sawmill.

Even tho it is only a second class geyser there is a fascination about the Sawmill both in action and repose, and its delicate, flower-like crater sorely tempts visitors from Podunk and Hickville to inscribe their names and that of their fair city. Sawmill plays for periods of several hours a number of times a day. Its eruptions consist of recurring nervous spurts that may reach to feet but are seldom more than half that high. Just south of it is Liberty Pool whose action is similar on a smaller scale. This is the original Tardy of the Hayden Surveys while "Liberty" was applied to a quiescent spring a hundred feet farther south.

As the trail approaches the foot-bridge several cone like springs are seen rising from the water's edge. Above the bridge is the Chimney while below is are the Bulgar, Chum and Witches Cauldron. All are somewhat periodic but irregular. A detour of several hundred yards down the river to the bend will bring the visitor to an interesting group of springs. Two are especially noteworthy; one, a huge inky, boiling vat almost at the brink of the stream to which the name of Witches Cauldron was given by Hayden andto which it is far more applicable than the present Cauldron near the bridge; and the other a high white dome of geyserite with several curious springs on the top called Limekiller by the Hayden party but recently changed to Sea Shell.

Returning to the bridge and crossing it, we may profitably explore the downstream bank before we visit Castle. Passing a cone like those on the other bank we come to a group of miniature geysers the two most active of which are the Wash Tub and Dish Pan, a distinction which will strike the casual observer as rather delicate. The ground beyond is a mire perforated with many vents. Terra Cotta Spring is worth attention as the rhyolite (not sinter) about the opening has the texture and tawny orange color of that type of pottery. Another hundred yards brings us to the Spanker, remarkable chiefly for its setting in the marshy bank of the Firehole. Its noisy splashing can be heard distinctly on the road several hundred feet back from the river at this point. On the far side of the road are the Orange Springs which support a heavy growth of yellow, orange and red algae.

Returning by way of the road we pass Castle Geyser, the largest and most imposing cone of all the active geysers in the Park and, assuming the rate of deposition approximately uniform, probably the oldest geyser now playing. The resemblance to a ruin of the middle ages is very striking when viewed from the

river where its elevation gives an illusion of distance. It is best seen and photographed from the farther bank of the Firehole where the winding river in the foreground completes a picture of much charm.

Since the growth of its formation at the present deposition would be inconceivably slow even in a geological sense, it has been generally regarded that Castle was formerly much more active than it is at present. Today its normal activity is a steady steaming with jets of water thrown 20 or 30 feet every minute or two. Every four to eight weeks it has an exceptional eruption during which the water is thrown well over a hundred feet for a few minutes followed by a tremendous steam period that lasts a number of hours and whose hollow roar is audible for several miles in winter. These eruptions are usually preceded by a cessation for several days of the characteristic spurting.

Beside the cone of the Castle is the hot spring first called Castle Jr., but now known as Tortoise Shell and those who derive pleasure in finding resemblances to living creatures in inanimate objects will be able to trace not only the shell of the tortoise, but his head, tail and legs (several of the latter missing) as well. Apart from this the Tortoise Shell has the distinction of being the hottest spring in the Park (203° F., i.e. six degrees above the boiling point at this elevation). It is somewhat periodic and its ordinary activity is apparently unaffected by Castle; however, its level is lowered about six inches after powerful eruptions of the latter. The Crested Pool nearby (sometimes known as Castle Well) is a circular pool with a raised rim whose unusual depth (40 feet) gives it a well-like appearance. At the foot of the slope along the river is the Moter, a small geyser that plays spasmodically at irregular intervals to a height of ten feet.

The trail crosses back to the east bank of the Firehole and as we climb up to the Lion Group we find spread before us the Snowy-white slope of Geyser Hill, the most active part of the Upper Basin. The statuesque grouping of the four cones on the high mounds above suggests some of the lions of Thorwaldsen, the Danish animal sculptor, and when viewed from the south the cone of Lion Geyser does bear a marked resemblance to the body and maned head of a reclining lion. In spite of the proximity of the four vents there is little inter-relation in their activity. The Lion plays normally several times a day, the jet reaching 50 or 60 feet and the display lasting several minutes. At frequent intervals it seems to have something analogous to a "nervous spell" and on these occasions it spurts up every half hour or so, sometimes playing 12 or 15 times during the day. These latter eruptions are largely steam and altho they begin with the characteristic hollow roar that the normal action does, last only a few seconds. The Little Cub plays a few feet every hour or two and is wholly independent of the others. The Lioness is practically extinct, altho a few eruptions have been recorded in the past decade. It is the largest of the group, occasionally reaching 100 feet. The Big Cub played simultaneous with it and has been dormant for a like period. A large irregular hole in the sinter at the base of the Lions' Mound sometimes erupts with much vigor and it is quite probable that its activity may reduce the steam pressure in the tubes of Lioness and the Big Cub sufficiently to account for their present quietude.

The customary route swings to the left from here along the north and east border of Geyser Hill, passing many vents of little intrinsic interest but which attract much attention on account of their conspicuous position. The Goggles are connected twin pools one of which has become closed with deposit. The open vent fills frequently and overflows into the other. The Ear (formerly the Devil's Ear) is a relic of the days when the chief interest in the Park was its satanic associations. Algal Pool has an exceptionally vigorous growth of Algae, probably due to the unusual amount of carbonic acid gas in the spring. Doublet Pool presents an extreme example of the deposition of geyserite at the rim of a spring to form overhanging ledges. Within the spring similar ledges can be seen that were built when the water stood at that level. The water level is gradually being raised as each outlet is eventually filled with the deposit and the entire process repeated at the new level. In Beach Spring the submerged ledge is quite symmetrical and the cooler shallow water over it permits the growth of algae producing a circular orange rim that contrasts pleasingly with the blue center. The Drahon is a small geyser that plays half a dozen times a day spitting fire and smoke (in this case water and steam) after the manner of orthodox dragons.

The Nature Trail that begins near this point leads to Solitary Geyser whose extensive formations and frequent steam clouds are so conspicuous from the road. It is remarkable for its elevation (200 feet above the river) which is taken advantage of by the operator of the Geyser Baths to furnish a continuous supply of hot water for the pool. Solitary is in eruption about half the time, three minute periods of activity alternating with equal ones of quiet. "Old timers" state that before it was piped it was only a quiescent spring. If this is true it is an interesting example of the result of reducing the pressure (and thus lowering the boiling point) by removal of some of the superincumbent water in a spring where the equilibrium is delicately balanced and so inducing eruptive activity.

Retracing our steps we come upon Sponge Geyser, a name so appropriately put that it just naturally fastened itself upon the little geyser without waiting to pass through official channels. The color is due to oxides of iron and is unusual in this area, the only other notable instance being the lining of Castle's crater. Tho small, the Sponge is a model of regularity playing to an elevation of six inches every three minutes. The chief distinction of the Pump is the fact that it is the only one of the several thousand of thumping holes in the Park that has a name. Its neighbor, Topaz, has more solid claims to distinction for it presents a striking example of that peculiar state of equilibrium that exists in some springs enabling water above the boiling point (in this case 5.6 degrees) to flow quietly without violent ebullition. A small vent in the sinter nearby has developed into a very active little geyser in recent years. The unusual texture and color of the sinter is interesting. In this vicinity also is the little geyser once known as the Model whose miniature crater and tiny eruptions are a perfect replica of some of the monsters in this neighborhood.

On the mound beyond is a pool some 25 by 35 feet whose placidity in repose gives no conception of its violence in action. Giantess is a geyser that does not need to be watched as its eruptions are accompanied by a young earthquake, while the noise is less that of rushing steam than a deep subterranean rumble felt rather than heard like the pedal tones of a colossal organ. It usually goes into action with an explosion-like outburst that hurls the immense quantity of water in the crater into the air in a single instant, the mass as a whole rising 50 or 60 feet with jets shooting through it to twice that height. The end of the eruption is largely spray as the remaining water in the tube is blown into a mist by the terrific pressure and the ensuing steam period lasts from four to six hours during which the roar gradually subsides. After the eruption about 72 hours are required to fill the crater to overflowing again. The orange-yellow algae in the outlet lose their color the first day after they are deprived of their water supply by an eruption and by the third day are thoroughly dessicated with a harsh, chalky texture due to embedded particles of silica. Usually the algae do not fully recover their color until several days after the crater is overflowing again. Of late Giantess has been emptying several times a year at extremely irregular intervals.

Two other vents on the same mound are closely associated with Giantess, their ..rwater-level falling during eruptions of the larger geyser and rising again as it fills. The nearer one, the Vault, is also an independent geyser that plays infrequently to a height of 20 feet. Its activity usually drains Teakettle, the third of the trio, but does not apparently affect Giantess. Teakettle is a crested pool that boils vigorously at one end. Its water level is variable and occasionally overflows for short periods. It is reported to have erupted but this has never been verified.

A short detour is usually made to the east before descending to the river again. At the edge of the timber is Mottled Pool, an extinct vent with vegetation growing down to the water level. A faintly steaming mass of disintegrated sinter back in the woods gives evidence that this part of the hill was formerly much more active. Continuing on the trail we come to an irregular pool whose milky white lining gives the water an azure tinge.. This is the former Infant, a name now fallen into disuse; it is connected with Giantess and its water level falls about a foot during eruptions of the latter. A few yards beyond is the Butterfly, until a few years ago an active little geyser whose formation produced in a remarkably life like way the wings and body of a butterfly. The pool on the high mound beside it is a geyser altho not often seen in eruption. It plays with much power and its eruptions are like those of a miniature Giantess.

The trail back to the foot-bridge from Giantess swings to the left before passing Beehive Geyser. On the left are the ancient remains of a once powerful geyser whose formation has become so decomposed that it is able to support a sparse growth of vegetation. Below it are the twin craters of Abemone Geyser perhaps the most attractive "baby geyser" in the hill. It usually plays for a half minute out of the nearer vent which suddenly drains and the farther opening plays for a few second longer. Action is irregular but frequent. Nearby is a jagged opening in the sinter that was blown out in 1922. This is the so-called New Geyser; it was very active for two years playing every twenty minutes but is rarely seen of late and then only with much reduced vigor. Several other openings in the vicinity are miniature geysers. Nearer the river is Cascade Geyser, inactive for a number of years; its former eruptions sent out contents of the pool cascading over the high bank into the Firehole. At the foot of the sinter embankment and almost submerged in high water is the Sputtorer.

Without doubt the greatest loss to the Park in recent years is the almost complete inactivity of Beehive Geyser whose cone is the small but conspicuous dome of geyserite on the slope above the bridge. This is unquestionably the most graceful and fountain like of all the geysers in the Park and seems to approach most nearly one's pre-conceived idea of what a geyser looks like. The writer has never seen an eruption of Beehive that did not arouse the most enthusiastic admiration of the onlookers, including a sophisticated sage brusher who had sat through his first eruption of Old Faithful without comment, only remarking at the end, "Is that all it does ?"

The vent of Beehive is scarcely two feet in diameter and the tremendous steam pressure forces the water through this narrow crifice to a height that altho somewhat short of Grand, appears greater on account of the slenderness of the jet. So great a pressure acting on such a slight volume of water dissipates it into a spring that falls to leeward as a fine rain. It is for this reason that there is no mound or platform surrounding the vent and that the cone itself is so small. When there is no wind the jet may rise to an elevation of 220 feet; this height is sustained for five minutes accom panied by a whistling roar that is distinctive and easily recognized. A half hour steam period follows the water eruption. In the "old days" Beehive played alone frequently but most often a few hours after Giantess. Nowadays it erupts several times a year and occasionally an eruption of Giantess is followed by one of Beehive in the traditional manner.

Since the present inactivity of Beehive is usually ascribed to excessive "soaping", a practice once prevalent in the basin and of which Beehive was the chief victim, it will be interesting to visit the spring where, according to local tradition, the effect of soap in a geyser was first discovered. This is Chinaman Spring on the west bank of the Firehole opposite Cascade Geyser in a group that includes Blue Star and an unnamed spring. Many years ago a Chinese employee of the early hotel operated a hand laundry here using the spring in question for a wash-boiler, a purpose for which it is admirably adapted. One day he put in more clothes and soap than usual into the boiler and the ordinarily quiet spring erupted violently, scattering the establishment in many directions.

The action of a soap solution is to impede the convection currents in the tube which in a spring with a ... normally free circulation would permit ebullition deep within the crater before the surface water boiled and thus induce an eruption, while in a geyser it would greatly accelerate activity and increase the violence of the ensuing eruption. However, the two conflicting theories regarding the fate of the proprietor, that he was drawn down into a vent and was later encountered in China by a missionary, and that he was thrown into the air by the explosion and hasn't come down yet, rest on a less scientific basis.

After the caprices of so many former favorites it is pleasant to record the unswerving regularity of Old Faithful. For the fifty-seven years in which it has been known its interval has rarely departed from an hour and a few minutes and nine tenths of all the recorded observations, from those of Dr. Peale in 1872 to the present day, are between 62 and 67 minutes. There is, however, a marked variation at times in the height of the jet and the duration of the eruption. This is sometimes noticeable in late summer at the end of an exceptionally dry season and is the general rule in February and March. The writer has seen abortive eruptions during these months that were little more than brief spurts to a height of 50 feet.

THE UPPER GEYSER BASIN Phillips

In spite of the symmetry of the cone the crater is merely a fissure in the underlying formation through which a tube has been built by the deposition of the silica in solution. The line of the fissure can be traced for a considerable distance in both directions from the top of the cone and jets of steam are blown out of it at several points for a few moments before the eruption. The present active cone is surrounded by four dead ones, two of them still steaming, whose semi-circular grouping around Old Faithful intimate a relation to the latter that remains one of the most fascinating problems of the Park. Three of the four cones are so far disintegrated that it seems possible they were already inactive by thetime Old Faithful began operations. It has been suggested that all four were at one time active geysers which became dormant for one reason or another and that their pent up energy developed a fissure in the center of the group and eventually a new geyser (i.e. Old Faithful), but the theory would be more plausible if the process were reversed with the other vents the result of the cessation of the inner.

To complete a survey of the Upper Basin it will be necessary to return to Giant Geyser and take the Black Sand Basin road referred to at that point.

At the top of the first slope on this road passes through a thermal area of greatest interest. Splendid, the quiet pool back near the ridge, was at one time one of the major geysers of the Park. After several years of irregularity it ceased playing in 1892 and since that time Daisy, formerly an obscure and unnoticed hole in the formation, has developed into a geyser that while it scarcely attains half the elevation of Splendid, more than makes amends by its frequency and regularity. This transfer of activity is but one manifestation of the remarkable sympathy existing between all the vents in this area. Bonita, the little spring across the road fills to overflowing before eruption of Daisy; as the latter plays it drains rapidly, leaving at the end a pool scarcely more than a foot in diameter. Eruptions of Daisy also lowers the water level in Splendid and Brilliant while the incessant activity of Comet is reduced for a short period. Much of Daisy's ejected water is redrawn back into the crater, a fact to which is attributable its unudual frequency. Its interval is between one hour and a quarter and an hour and a half and its only irregularity is an occasional vacation for a day or two. Its elevation which has been increasing of late years is about 60 feet and it is significant that this geyser as well as the neighboring Comet and the now dormant Splendid all play, or played, at an angle whose direction for all three is approximately the same (east).

As the road leaves this area it passes the White Pyramid, the twenty-five foot cone of an extinct spring or geyser whose orifice has been closed by deposition of geyserite. It still steams , feebly near the top. Three hundred yards beyond is the Punch Bowl whose formation combines characteristics of both a hot spring and geyser. It has not been seen in eruption for fifty years but the surrounding sinter indicates that it may have been once an active geyser and early explorers declare they saw it play. It was at one time piped to supply hot water for the Wylie Camp and it seems likely that if the spring has had any eruptive tendencies recently they would have made themselves evident where so much of the pressure was taken off the water column in the tube.

Another quarter mile brings us to Black Sand Spring. The black sand so abundant in this part of the basin is pulverized obsidian, a glassy form of the prevailing rhyolite, and the lining it makes in the present spring gives the latter a tint not found elsewhere in the Park, a dark blue that is reminiscent of the ocean in certain aspects. The overflow of Black Sand Spring is a shallow basin called Specimen Lake . Here the silicious water has been drawn up into the interstices of the standing dead trees by capillarity producing so-called "petrified trees" but the process is not true petrification since there is no replacement of the wooden fibre but merely a filling in of the cellular cavities.

Thermal activity becomes more and more evident as Iron Creek is approached and just before the foor bridge is reached the road passes the Spouter, a constantly playing geyser whose steady turmoil occasionally develops into a real eruption that throws jets in every direction without reaching a height of more than 20 feet. These eruptions continue until the crater is dry; it commences to refill shortly and the normal splashing is resumed. Above the bridge on the same side is Green Spring whose color varies from year to year, probably with

fluctuations in its temperature, some seasons rivalling the more famous Emerald Pool. At the farther end of the foot bridge is a spring that has built itself a huge cauldron like crater out into the bed of the stream. This is Cliff Spring, in reality a very respectable geyser that erupts at intervals varying from several weeks to several months. Its eruptions are sometimes 50 feet high and are rendered unusually spectacular by the picturesque setting. On the right hand side of the walk is the overflow of Sunset Lake and Rainbow Pool that are inferior to the better known Prismatic Lake of the middle basin only in their smaller size while their accessibility makes them more available for a close examination of the various types of algae.

The walk completely encircles Handkerchief Pool, a "trick" spring that seems to fascinate some of its visitors. It is obvious to anyone watching its action that the movement of the handkerchief is controlled by ascending and descending convection currents. The object is drawn into the tube by the downward movement of the water around the periphery of the funnel and brought up again by the rising current of heated water in the center. The long interval that sometimes elapses before it is returned does not indicate that it has gone down to abysmal depths as is usually deduced by the audience but merely that it was caught on some obstruction a foot or two below the opening.

A short walk toward Niobe Creek at the foot of the Madison Plateau brings the traveler to Emerald Pool. This spring has many claims to being the most beautiful in the Park and is without doubt the finest of the green pools. The nature of the crater is such that the water is at practically the same temperature at all points which favors a uniform development of the algae lining the interior and a corresponding uniformity in color, in this case a lemon yellow which shining through the transparent blue of the water produces the unclouded green characteristic of the gem for which it is named.

Leaving the foot bridge the road turns to the east and returns to the Firehole River. The low mound on the left is of unusual interest. It was evidently an active geyser at one time but later took on the characteristics of a hot spring probably as its vent became partially closed by geyserite and the steam found an exit elsewhere. However, at rare intervals, seldom more than once a summer, it erupts with extraordinary power ejecting the little water in the tube as a spray while the released steam rushes through the narrow opening with a peculiar high pitched roar that has given it the name of whistle. As we come out in the open steam can be seen rising from Pine Springs, an unimportant group of springs in the timber at the left. Just before the junction with the main road are the Three Sisters, a multiple spring with three craters connected by challow channels. It is a small geyser with three vents, all in the "Big Sister" and the small bay connected with it. The geyser is evidently not a powerful one and seems to experience difficulty in forcing its jets through the overlying mass of water. There are a number of eruptions a day, one of the vents playing oftener than the others. None of the groups exceeds 10 feet in elevation. Between the three Sisters and the rear of the Inn are the Myriad Springs, remarkable more for the number of vents in the group than for their intrinsic interest. Still a few are worth attention. Here are to be found the only pink and red paint pots in the Upper Basin while beyond are the springs that supply the hot water for the winter keeper's residence as well as his poultry house and green house. There is also a shattered mass of formation that indicates that this part of the [illegible] basin was once an active geyser area.

This concludes the portion of the basin ordinarily seen by the tourist during his stay at the hotel or the camps, but recently developed nature trails have opened an attractive area extending along the Firehole from Old Faithful Camp to the first bridge. This end of the basin is interesting chiefly as a study in the last stages of thermal action; the large cones of its former geysers are either extinct or reduced to a small opening in the center while most of the old sinter slopes are covered with soil and vegetation has invaded the area to the very foot of the old cones. There is more activity in the warm basin in the lower end of the canyon of Snow Creek, a tributary of the Firehole; here may be seen several large boiling mud pots unlike anything in the Upper Basin. Most of the springs from here to the bridge are on the river banks on both sides and several are within the stream itself. A few feet above the bridge are some "petrified deer-tracks" that attract much attention. They are, of course, not true petrification but the comparatively recent imprints of the deer in the silica depositing algae growing in small springs at the waters edge, made probably as the animals came down to drink. When the heated water ceased to flow the algae died and the gelatinous geyserite hardened, preserving the tracks in flinty sinter.

THE UPPER GEYSER BASIN Phillips

Lone Star Geyser was discovered by the second Hayden Survey (1872) and was by them called Solitary Geyser and the basin in which it is found the "Third Geyser Basin of the Firehole". Its location, in a straight line connecting the Upper and Shoshone Basins at a point nearly midway between them has suggested that the three geyser areas may be the surface manifestation of some deep-seated fissure in the bed rock but more likely its situation is a mere coincidence since there is more or less thermal activity all along the Firehole from this point up to its source in Madison Lake. In any case there can be little doubt that the valley in which Lone Star occurs was once a geyser basin of major importance. All the phenomena are in a dying condition and most of the surrounding swamp overlies deposits of decomposed sinter. The vent of Lone Star itself shows the final stages of a geyser cone and the orifice is nearly closed. It seems unlikely that a mound of its dimensions (ten feet by fifteen in diameter) could have been built by anything else than a geyser of large size and today the jet that spurts out of this imposing structure is so small that it has been disrespectfully compared to a factory whistle. The cone in its woodland setting is the chief attraction; it is perhaps the most beautiful example in the Park with its finely beaded exterior and vertical bands of delicate color. Eruptions occur from two to four hours, largely steam with the little water blown into a fine mist, and make up what they lack in elevation by the unusual display of power as the confined energy struggles to find egress through the nearly closed crater.

* * * * * * * * * * * * * * * *

MORNING LECTURE

OLD FAITHFUL

By James D. Landsdowne, Ex-Temporary Ranger

The THREE SISTERS are rather unimportant pools. The object of greatest interest is the stump, which was not thrown in, but is what remains of a tree which grew there. From a vent near the stump water sometimes spouted to a height of four or five feet. The THREE SISTERS present a good view of how the algae wary with the temperature of the water. Near the stump where the water is the hottest, the algae are nearly white. As the water flows off in this direction (the crowd starts to move after the guide) it cools and the algae are much darker. You were told yesterday afternoon by the guide that the algae are closely related to the seaweeds and grow in Yellowstone Park in waters of a temperature as high as 197 fahrenheit. The trees on both sides of the road were killed by the hot water from the THREE SISTERS. The white material at the bases of the trees is silica that has been deposited as silicious sinter by the water drawn up by capillary action. That process will continue no longer, because there is nothing left to draw up the water. You know that in order to have trees petrify, it is necessary for water carrying mineral matter to replace the structure cell by cell. Usually petrified trees are fallem, but in the Lamar River valley, in the northeastern part of the Park, petrified trees are found in their natural, upright positions; twelve layers of them in fact.

These flats are used, during the winter, as feeding grounds by the elk. With the approach of warm weather, the animals go to higher altitudes. There is no necessity, I believe, for me to enumerate the animals of the Park. I might state that the only animals that it is permissable for the rangers to kill are the wolves, the coyotes and the mountain lions, and these only in restricted areas, designated by the superintendent of the Park. To set at ease the minds of the ladies, I'll add that there are no rattle snakes in the Park, although there are some harmless ones such as water and bull snakes.

The trees we are passing are lodgepole pines, identified by two needles in each cluster. In this portion of the Park we have mostly lodgepole pines, with just a sprinkling of firs and of spruces. In other sections where other evergreens are found, as well as deciduous trees such as willows and aspen, some other species may predominate. The flowers are not to be picked, because we want the tourists who come after you to have the same opportunity of enjoying them as you have. They are (usually) lupine, yarrow, aster, Indian paint brush, compositae, and larkspur. (Some fringed gentians and monkey flowers later on in the trip - point out flowers).

MORNING LECTURE OLD FAITHFUL Landsdowne

The Park, as you were told by the lecturer last night, was made a National Park in 1872 by an Act of Congress, after considerable agitation by such public spirited men as Washburn, Langford, Doane and Hedges, to mention some. There are practically no Indian legends about the Park. Some of the early trappers told some good yarns; Jim Bridger, for example, is accredited with this one:

He once located camp near a place that had the property of returning an echo after an interval of six hours. This he utilized as an alarm clock, calling out as he retired, "Time to get up". Six hours later he would be awakened by the sound.

Another one sometimes accredited to Bridger is this:- a portion of the Park area was cursed by an Indian chieftain so that everything was petrified. The most astounding feature of the region was discovered after it had been noted that not only the trees and flowers, but also the birds, waterfalls and sunshine were petrified. One evening Bridger attempted, too late, to pull up his horse on the bring of a wide and deep chasm. The horse went right on over the chasm, and continued on the other side as tho it hadn't been there. Bridger concluded from that that even the force of gravity was petrified.

(Following paragraph suggested by Superintendent Albright).

Briefly the explanation of geyser action is this: the long, irregular geyser tube extending into the earth for a few hundred feet, becomes filled by melting snows and other surface waters. This water in the tube is heated by superheated steam rising from the uncooled mass of lava beneath. It is well known that the pressure in water (being due to gravity) increases with the depth and that the boiling point rises with the increase in pressure. Finally, steam forming at the bottom of the tube causes the water to overflow at the surface suficiently to lessen the pressure in the tube. There then is a great flash of steam which expels the water producing the eruption.

The WHISTLE plays once or twice a season. Some visitors who were close by during the last eruption were surprised because, as they said, "We could hardly hear ourselves think". As a matter of fact the sound can be heard for half a mile. Visitors from the east often take this for the source of the popular drink. I am often asked "Will the geyser play if one whistles in the right key ?" To which I always answer, "Try and see" !

After we cross the creek kindly stay on the walks. On the left is the CLIFF SPRING with a temperature of 196 degrees fahrenheit. It always boils as it is doing now, and is noteworth because the hot water in it is so close to the cold water in IRON CREEK. It is possible to catch fish in the creek, swing them over into the pool and cook them without removing them from the hook. However Departmental regulations prohibit this inhumane practice. Otherwise I'd gladly demonstrate ! On both sides of the walk you will see some of the best algal growth examples in this Upper Geyser Basin. The RAINBOW POOL, on the left, is more beautiful than SUNSET LAKE, on the right. SUNSET, however, is hotter and larger. We seldom see any more of SUNSET than we are seeing today, because of the quantity of steam emitted. This is the famous HANDKERCHIEF POOL, 182 degrees fahrenheit. Contrary to the popular tradition, it does not cleanse the handkerchief. A handkerchief thrown in at the far side of the pool will be carried by the convection of currents down into the crater, and after a few seconds, will be returned to the surface (Ihope), where the bubbles are rising. Let's go this way. This EMERALD POOL, is considered the most beautiful green pool in the Park. As a matter of fact the water is the same as the water in the blue pools but lower in temperature, the temperature being only 157 degrees fahrenheit. That gives the yellow algae a chance to grow and the yellow showing thru the blue produces the beautiful greenish effect. The logs you see were thrown in by visitors, and a few years ago choked the pool. During the winter the National Park Service succeeded in removing most of them. The logs have been carried below the surface by a deposition of silicious sinter from the water, while the continued deposit has acted as a cement to fasten the logs to the rock. Now it is practically impossible to pry them loose. These logs thrown into this beautiful pool by thoughtless persons years ago are examples of the type of vandalism we so earnestly try to discourage. The Park is yours, for your enjoyment and pleasure, and we urge you to be thoughtful of the millions of others who are coming after you and who also have the right to appreciate the loveliness of it and for whom it should be preserved.

MORNING LECTURE OLD FAITHFUL Landsdowne

The SPOUTER, 200 degrees fahrenheit, was so named because it boils this way all of the time. Of recent years it has developed a habit of darining, which it does now on the average of once a week. Quite suddenly the water drains out, leaving the bowl entirely dry. It remains so from thirty to sixty minutes, when it refills and the boiling goes on as before.

The BLACK SAND POOL, 199 degrees fahrenheit, is so named from its location in the BLACK SAND BASIN. It is one of the most beautiful of the blue pools; it is too hot to permit the growth of algae, and it is 40 feet in diameter. Beyond the BLACK SAND POOL is a region known as Specimen Lake, because from it have been taken numerous interesting specimens. The . . trees have been killed by the hot water and are encrusted with sinter, the same as those about which I spoke at the THREE SISTERS.

The black sand from which this basin is named, is a black glass called obsidian. Obsidian is a hard, dark colored, vitreous rock which results when lava cools before crystallization sets in. Those of you who came from Mammoth, no doubt, saw OBSIDIAN CLIFF, twelve miles from Mammoth. You who came from West Yellowstone will see it later on. To return to the black sand. It is used in large quantities on our roads and makes a good road if watered frequently. 107 miles, constituting an important part of our main road system, are sprinkled twice daily.

The PUNCHBOWL greatly resembles the TEAKETTLE you saw on the trip yesterday afternoon. The PUNCHBOWL is one degree hotter than the TEAKETTLE, being 202 degrees fahrenheit in temperature, more impressive, and more beautiful due to the growth of the algae. Another difference is that while the TEAKETTLE drains after every eruption of the GIANTESS, the PUNCHBOWL never drains. It is said that in 1918, as a result of a certain constitutional amendment, the PUNCHBOWL did drain, and refilled with water, so that it never since has been the popular stopping place it used to be.

The DAISY plays on a seventy minute to two hour interval. It gives a very attractive display, sending the water to a height of 30 to 70 feet for three minutes. The DAISY will play in ..... minutes, so we may as well wait for it, rest, and remove the stones from your shoes. Behind you, across the road, is an indicator for the DAISY, called the BONITA POOL. About ten minutes after the DAISY plays the BONITA starts to drain, and drains down to about 18 by 18 inches, slowly. Then it refills until it covers an area perhaps four feet square. Shortly after the BONITA attains its greates extent the DAISY plays.

Another pool closely connected with the DAISY is seen beyond it, on the same side of the road. That, BRILLIANT POOL, 192 degrees fharenheit, drains about a foot during the eruption. During the next interval it refills. Watch not only the DAISY, but also the BRILLIANT; and after the DAISY stops, notice how the water rushes back into the crater without refilling it. The large cone in the distance is known as WHITE PYRAMID and hasn't erupted for at least fifty four years.

The RIVERSIDE GEYSER, named of course from its location, gives a beautiful display, as it plays to a height of 80 to 100 feet, arching the water in this direction so that it falls into the river, the FIREHOLE. By some this geyser is called the musical geyser because it plays "Over The Waves". You must remember, however, that OLD FAITHFUL plays "'Neath the Silvery Moon". The RIVERSIDE plays about fifteen minutes at six to seven hour intervals. It is rather regular and will play next at about.....o'clock.

The SPA POOL, 30 feet in diameter and with an apparent depth of 15 feet, is named for the European medicinal springs at Spa, because this pool was supposed to possess medicinal qualities. Occasionally, it spouts for a few minutes to some 15 to 20 feet.

Within recent years (1922-23) the INDICATOR (sign removed) has been known to play to a height of one hundred feet for fifteen minutes. (Evidence of ex-temporary rangers Robertson and Alcorn). It has an irregular interval.

The GROTTO has the most unique cone of all the geysers. The explanation offered for this is that the silicious sinter has been deposited around the roots of an upturned tree. That theory cannot be proven without destroying the formation, and naturally, that will never be done. You have seen on the trip enough overturned trees to enable you to see the similarity between the root system and this formation, I believe. The GROTTO plays much of the time, as its eruptions are irregular in length, 15 minutes to 8 hours, and the interval is from two to eight hours. The structure can be seen to best advantage when the geyser is not in action, and in missing the eruption not much is missed, as the water is

never sent higher than 30 feet. The ROCKET, beside the GROTTO, plays at the same time to a height of 15 to 20 feet. Occasionally, two or three times a season, it plays alone to a height of 50 feet.

This group consists of the GIANT, with the prominent cone, the MASTIFF, to the left and the BIJOU, still farther to the left. The BIJOU plays most of the time, from one cone or the other, sometimes from both, to a height of, as you see, about 15 feet. The MASTIFF seldom sends water more than 3 to 4 feet into the air. As the level of the water is almost that below the edge of the crater, the water doesn't seem to go even that high. Eruptions are irregular and infrequent. The GIANT is the geyser that sends a column of water to a height of 250 feet right at the beginning of the eruption. It maintains that height for five to ten minutes, then the column begins to lower, until at the end of the eruption, the water ascends to but 50 feet. The eruption lasts for from an hour to an hour and a half. The reason that I don't go closer is this. Recently (1923) water has been shot from several openings around the cone, even from the hole in which the sign-post is placed. This happens without warning, to a height of 8 feet for some. Consequently I don't want to run any risk of having you scalded. The cone as you already have noticed, is an imperfect one. Despite rumors to the contrary, the cone has been that way during more than the half century that the GIANT has been known. Whether it was formed that way or whether a portion was blown away by an exceptionally violent eruption is, therefore, impossible to say. The interval for the GIANT is six to fourteen days. The last eruption was recorded on the . . . ., so we don't look for one again before. . . . .

The OBLONG, 48 feet by 20 feet and sounded to a depth of 36 feet, formerly played to a height varying from 20 to 40 feet for seven minutes two or three times a day. In recent years eruptions have been less frequent. It isn't a great loss, because the peculiar shape of the crater, from which the geyser gets its name, and the beautiful rock formations inside and around the crater have always attracted more attention than has the eruption.

The MOTORBOAT is unusual. You can locate it about fifteen feet off shore by the white bubbles ascending. By listening carefully, you will be able to catch the faint put-put sound from which this gets its name. Visitors tell me that it sounds like a motor boat missing on one cylinder.

The INKWELL is so named because it presents the two colors, red and black. The red is due to algae, the black to a peculiar deposit of sulphides. The water is 200 degrees fahrenheit.

The algae in the ALGAL TERRACES, on the left, are growing in water flowing from the CHROMATIC POOL which you will see next. While the ALGAL TERRACES do not present the degree of shading presented in the vicinity of HANDKERCHIEF POOL, many visitors look upon the depth of color as a compensation.

The CHROMATIC POOL is so named because of the delicate shadings of color. The musical members of the party will provide any further explanation. The CHROMATIC, like this

BEAUTY POOL, is blue during the summer but more of a green during the winter. The reason being that the cold weather cools the water sufficiently to permit the yellows and oranges of the algae to become luxuriant. As at EMERALD POOL, the yellow, showing thru the blue produces a greenish effect. Altho the cold weather affects the pools, remember that it has no effect upon the action of the geysers.

WAVE SPRING looks as tho a succession of pebbles were being dropped into it. The water flows from one pool to the other. (Which way ?) The waves are, no doubt, formed by some peculiarity in the tube.

The ECONOMIC GEYSER was so named because practically all of the water expelled ran back into the crater. The only water lost was a small quantity blown away in the steam. The geyser played frequently to a height of 20 feet. The man who named it did better than he though, as the ECONOMIC hasn't been observed to play recently, except at rare intervals.

MORNING LECTURE OLD FAITHFUL Landsdowne

This group consists of the BURNING POOL, the large opening, the GRAND GEYSER, the opening to the far side of the BURNING POOL, and the TURBAN GEYSER, the small opening on this side, close to the crest of the pool. The TURBAN and the GRAND play together, and present an interesting comparison. While the TURBAN plays to a height of 15 to 20 feet, 40 at its best, the GRAND plays 150 to 200 feet. The TURBAN plays continuously, while the GRAND plays in a series of spurts varying, usually, from fifteen seconds to a few minutes in duration, and in number from six to sixteen. The length of the eruption depends upon the number of spurts, usually from fifteen to thirty minutes. The TURBAN plays thruout the GRAND'S eruption, and for fifteen to twenty minutes after the GRAND stops. The GRAND plays at intervals of from ten to twelve hours, and is, in my opinion, the most beautiful of all of the geysers. The BURNING POOL, 199 degrees fahrenheit, is alternately calm and boiling. The man who named it must have seen it in the latter phase, because he explained the name by saying that the bubbles of the steam coming to the surface resembled blue and yellow flames. The blue flames aren't hard to see, but I must confess my imagination has never been equal to the task of seeing the yellow. The BURNING POOL like the TURBAN is connected with the GRAND. The eruption of the GRAND causes the BURNING POOL to drain quite dry. It remains dry for thirty to sixty minutes, then refills rapidly to two thirds its capacity, filling to the brim more slowly. (Skinner). I have seen it refill within ten minutes of the end of the eruption. (Landsdowne). Then the alternating periods of calm and boiling go on as before.

These TRIPLETS were at one time considered to be the indicators for the GRAND, but that theory was exploded. They frequently display various degrees of fullness; for instance, the one on the end may be empty, the one in the middle half full, and the other one quite full.

The SPASMODIC plays from twenty minutes to sixty minutes to a height of from two to four feet, and one to four times a day. Its chief interest is due to the fact that it possesses four openings. Sometimes it plays from one, at others from two, three or all.

The SAWMILL plays more or less all of the time, as it plays from five to eight times a day, and each eruption lasts from two to three hours. The water spouts from twenty to thirty feet in height, with occasional spurts to fifty. Due to some peculiarity in the tube, the water is expelled by a circular motion, resembling, to the mind of the man who gave the name, a sawmill action. The picture of geyser eggs in the Haynes Guide was taken here. Geyser eggs are geyserite built up from a small nucleus by the action of the water. They are not planted to hatch new geysers.

Beyond the SAWMILL is the LIBERTY POOL, dry 90% of the time. Infrequently it fills, and even plays to a height of fifteen feet.

The WITCHES CAULDRON, 201 degrees fahrenheit, the CHURN, and the BULGER, 199 degrees fahrenheit, are not of any importance. The interest attached to them is due to the proximity of their hot water to the cold water of the FIREHOLE RIVER.

To your left, as you approach the bridge, don't miss the CHIMNEY. It is appropriately named, isn't it ?

RETURN TO THE HOTEL

Time can be filled in along the way by:

1.- Number of visitors for preceding year.
2.- Discussion of merits of various entrances.
3.- How the Park received its name.

AFTERNOON LECTURE AT OLD FAITHFUL FORMATIONS

By Ex-Temporary Ranger James D. Landsdowne

Approved by:
Superintendent Horace M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

Guide trip from the hotel, - to be reversed if starting from the camp.
1½ miles - 1 hour.

The brown building to the right is the Haynes Picture Shop. Whether you desire to buy or not, I advise you to stop in and look around. You will be well repaid. Before us is the Hamilton Store which sells almost everything from soft drinks to souvenirs.

The steam up on the hillside is coming from SOLITAIRE, a lone hot spring which boils continuously. From it water is piped for the geyser baths which we will see presently.

This is well named the Castle Geyser. Its cone stands 27 feet high. It sends water 30 to 50 feet into the air for half an hour when it erupts. Its habit is to play three or four days in succession, then rest for four to seven days. "Several times each season it has eruptions of an unusual character in which columns of water are thrown to twice their usual height". (Haynes Guide).

As this is your first meeting with a geyser, I might outline the theory of geyser action. Geysers are found in but few places; Iceland and New Zealand have some. The Yellowstone is the greatest geyser region in the world, and this Upper Geyser Basin is the greatest in the Park.

There are three requisites for geysers; heat, water and an irregular tube in hard rock. This is an old volcano region; and deep down the lava is still hot. Thus we have one of the three, heat. The second, water, is supplied by the abundant rains and snows. The third, hard rock is this silicious sinter or geyserite.

When the water from the melting snows seeps toward the interior of the earth and encounters the heated gases and vapors rising from the hot lava, its temperature is raised until some turns to steam, and that supplies the force to throw out the rest of the water. In some way cavities or walls, and tubes have been formed in the hard lava. The increased pressure as we go toward the center of the earth requires higher temperatures to boil water, i.e. change it to steam; obviously, therefore, the nearer the water is to the surface, the lower the temperature required for boiling. Now imagine a column of water (using arm as illustration). The lower the water, the hotter the rock, so a bit of water at the bottom of the column is changed to steam. In its attempt to escape, it raises the whole column. That raises the water to a point where less pressure is exerted against it, so less heat is required for conversion into steam. Suddenly a large amount flashes into steam which forces out, in an eruption, the water above it. That is, roughly, the way in which geysers work.

This colored material on the geyserite, is not iron but a plant growth known as algae. I ask you not to step on it because stepping on it kills it and we want the visitors later in the season to see it too. You can see where it has been trampled; let us hope by visitors who didn't realize the damage they were doing. The algae are hot water growths and vary in hue with the temperature; the hotter the water, the lighter the algae. So it ranges from colorless to brown, thru yellow, orange, red and green and is an indicator for the temperature of the water.

This CRESTED POOL or CASTLE WELL is about 193 degrees Fahrenheit so you see no algae. The best view is from the Castle side. You get an idea of the clarity of the water when I tell you that you can see down about forty feet. I am frequently asked whether geyser water is fit to drink. Government chemists say there is nothing in the water which would make it unfit for drinking but advise against it because it contains so much mineral matter in solution. It contains silica, iron, arsenic, chlorine, calcium and many other substances; in small quantities, of course. The water of the river yonder, the FIREHOLE, is drinkable but is not palatable, being warm due to the number of geysers and hot springs along its banks and emptying into it. Water for the purpose of drinking in this region is piped long distances, the hotel and the camp each having their separate sources.

AFTERNOON LECTURE AT OLD FAITHFUL FORMATIONS — Landsdowne

(If the SAWMILL is playing point it out before starting down the hill. Usually there are some flowers in bloom at the small bridge. Point them out, name them, and caution visitors against picking them).

This FIREHOLE RIVER was first called BURNT HOLE by the Indians because of a forest fire at one time. It joins the GIBBON to form the MADISON, which in turn joins the JEFFERSON and GALLATIN at Three Forks, Montana, to form the Missouri. The fishes are chiefly trout, and no license is required for fishing within the boundaries of the Park. The day's limit is ten fish, of a minimum length of eight inches.

This is the Lion Family; the one with the prominent cone is the LION, this opening is the LIONESS, the LARGE CUB is there, and the SMALL CUB here (point out). The LARGE CUB and the LIONESS have not been observed to play for a number of years. The SMALL CUB plays to a height of 3 - 6 feet, for fifteen minutes every hour or two. It starts without warning, so don't get too close. The LION plays to a height of 60 feet several times a day. The LION can be seen from the veranda of the hotel, and no doubt you will see an eruption of the LION during your stay in the vicinity.

These names, IRON and ARSENIC POOLS, signify nothing. Iron and arsenic are found as I told you in some of the Park waters, in small quantities. The coloring is not due to iron but to algae, as I explained at the CASTLE.

(Somewhere along the trip OLD FAITHFUL will erupt, so tell about it when it happens. If the start of the trip is made from the Camp, stop at OLD FAITHFUL on the way to the CHINAMAN).

OLD FAITHFUL was named by the Washburn-Doane Expedition of 1870, because of its dependability. As a matter of fact, its interval does vary. Although, usually, it can be depended upon for an eruption every sixty-two minutes, it is sometimes sixty and sometimes eighty. The water mounts 125 to 170 feet in the air and the eruption lasts four minutes. A very pretty effect is obtained when the hotel plays its searchlight upon it. This is done the first eruption after dark. The best effect is obtained from the side opposite the light.

Across the road from OLD FAITHFUL is located the ranger station. Stop in for any information; there's a ranger in charge until late in the evening.

This is well named the EAR. It does not erupt, but (pointing out) the little fellow at the side spouts all of the time. The rangers have named it the Earring. This was once known as the Devil's Ear, and you'll find it so marked on the old maps. It is said that the trappers used to come here to talk to his Satanic Majesty below. Once, during a particularly bad winter, they so annoyed him that he could get no rest. Therefore he fashioned a flap and buttoned it across so he could have some quiet. The Earring marks where the fastening was.

ALGAL POOL is so named for the quantity of algae present. The color is so deep, showing that the water is cool. That means, however, comparatively. Don't stick your fingers in it.

This BEACH SPRING is one of the most beautiful I can show you. The rock, geyserite, has been deposited in a ledge. The algal growth makes it look like a beach, doesn't it ? By comparing the shades you will readily see that the water is hotter at one side of the pool and also that the water here is hotter here than that in the pool we have just left.

(I can't recall the name of this, located right beside the BEACH SPRING and near the DOUBLET POOL). This. . . . .plays about fifteen feet high a few times a season. (Landsdowne) for about three minutes. It is chiefly of interest because it has two vents, one in the center, the other here at the side. Sometimes it plays from one, sometimes from the other (Skinner).

Be very careful here and stay away from the DOUBLET POOL. The reason is that the water extends some distance back from the edges under the surface and should one fall in he would be very badly scalded. The ledge has been built up very slowly as the deposit is but a small fraction of an inch yearly.

AFTERNOON LECTURE AT OLD FAITHFUL FORMATIONS Landsdowne

The SPONGE is quite aptly named. Here, by the way, is one place where the coloring in the geyserite is due to iron (Skinner). The SPONGE plays every three minutes for about 15 seconds, to a height, as you see of four feet. It isn't very big, but it works all of the time, so we're proud of it as every visitor sees it in action. Notice how the bowl fills and drains.

The PUMP is named for the sound it makes. It goes all of the time.

The TOPAZ is one of the hottest bodies of water in the Upper Basin. Its temperature, taken recently by men from Washington, was found to be 202.64 Fahrenheit, which places it slightly below the TORTOISE SHELL with a temperature of 203 F.

Be very careful here. I don't want to alarm you unduly, but the GIANTESS plays without warning, and, while I expect no eruption, one can never be too sure, and I want no one to be exposed to that mass of scalding water which is thrown out in all directions. That is why we have put up the dangerous sign. A lady asked me last Thursday, "What is that thing ?" I said "The Giantess". "Then why", she asked, "is it marked 'dan-ger-ous'?" We have here, as well as the GIANTESS, the TEAKETTLE and the VAULT. Let us consider the VAULT first. It is about thirteen feet deep and is always the quiet pool you see, except after an eruption of the GIANTESS, which drains the VAULT. It refills about a day and a half after the eruption. That shows its connection with the GIANTESS. How different the TEAKETTLE ! It boils that way all of the time. But it also drains after the GIANTESS erupts, and refills after the same interval as the VAULT. Then, instead of remaining quiet like the VAULT it goes on boiling. The GIANTESS plays irregularly, to a height of 100 to 200 feet for twelve to thirty six hours. The guide-book gives an interval of ten to twenty days. It makes so much fuss that an eruption cannot go unnoticed, as in the case of the CASTLE or GIANT which may erupt during the night without anyone being the winner.

Before you, on the far side of the FIREHOLE RIVER, is the Old Faithful Geyser Baths establishment, which, I mentioned as being supplied by water from the Solitaire up on the hill. The water in the baths is warm and unlike some of the water in this vicinity, very soft, forming a suds readily.

(A small opening on the hill between the GIANTESS and the BEEHIVE, not named in 1923. This little fellow plays every twenty minutes to a height of ten feet for one or two minutes. It started in 1922. So far it has remained without a name.)

The BEEHIVE is noted for giving a fine eruption. The water is ejected in a column to a height of 200 feet. The eruption lasts from six to eight minutes. This geyser erupts only after an eruption of the GIANTESS, altho the GIANTESS does play without being followed by the BEEHIVE.

(Cross the river to the CHINAMAN). Across the river you see the CASCADE GEYSER and the SPUTTERER, both rather unimportant. This pool is known as the CHINAMAN. It never plays, altho it used to. It was named for the Oriental who once conducted a laundry on the spot. You see it must have been very handy; hot water in the pool, and cool water in the river. Unfortunately, he dropped something into the pool one day and an eruption occurred, so the story goes, taking the Chinaman and his laundry high into the air. By a strange quirk of fate, he dropped back into the hole and has never since been seen. So this has been named the CHINAMAN in his memory. Some say he went all of the way thru to China, but I can't vouch for that.

This is the end of our trip. (Direct tourists to Old Faithful, the Geyser Baths, Hamilton's, the Haynes Shop and the Inn.)

EVENING LECTURE AT OLD FAITHFUL CAMP

By Ex-Temporary Ranger James D. Landsdowne.

Approved by:
Superintendent Horace M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

Many questions are asked me concerning the Indian legends of the Park. As a matter of fact, the Indians had no legends about this region, and were ignorant of it in a large degree. As late as 1877, when the Nez Perces were pursued across the Park, they had to impress the services of white guides.

Living within the area of what is now the Park were the Sheepeaters, who got their name because they lived at high altitudes and ate the mountain sheep. They probably took refuge here from their more warlike neighbors, as they were small in stature. Furthermore, they were undeveloped mentally, so nothing is learned about the region from them. To the southeast, southwest and south of the Park lived the Shoshones, to which family belonged the Sheepeaters; on the northwest were the Blackfeet, and on the northeast were the Crows. These Indians made incursions to obtain the obsidian for arrowheads and spear points, but were, no doubt, afraid to approach closely to the phenomena. Other causes may be assigned for the Indian's lack of knowledge of this vicinity. The Park is almost surrounded by high mountains; the timber is dense, and in the valleys around the game was more plentiful. So convenience, undoubtedly, had much to do with the Indians staying away.

The first information of the Park emanating from white sources came from John Colter, who accompanied the Lewis and Clark expedition of 1805 to the coast, but left it on the return to hunt and trap in this region. He did not return to civilization for five years, and when he did arrive in St. Louis in 1811, the region he described was derisively referred to as "Colter's Hell".

Further information was obtained from another trapper, James Bridger, in the employ of one of the trading companies. Bridger had a well established reputation of being a prodigious . . . liar, so its no wonder that his stories received no more than a hearing and a laugh. He tried editor after editor in his attempts to have his information printed, but was always laughed out of the office. In fairness to Bridger, I must add that later one of the editors offered him a public apology.

Bridger told several well known yarns. For instance:

(A.) He obtained a fine drink of water at the top of a mountain. After he had ridden to the base he was in need of a cool, refreshing drink, so searched for the water flowing down from the spring on top. He found it, but discovered, to his dismay, that the water was boiling hot. That was caused, he explained, by the friction encountered by the water while flowing down the mountainside.

(B.) While hunting one day, he spied a fine elk. He took aim and shot at the animal, with no effect. He was a good shot, so when a second shot failed, Bridger became angry, clubbed his rifle, and ran toward the elk. He was brought up short by a good bump on the forehead. Examination brought out the fact that he had run into a mountain of glass, Obsidian Cliff. When he felt his way around the mountain, he saw the elk at a distance of three or four miles, so not only was the mountain of glass but also it magnified, like a telescope.

Is it any wonder he had difficulty in making people believe such tales.?

Joseph Meek was in the vicinity about the same time (1829-30) but added little information.

In 1834, Warren Angus Ferris, a clerk in one of the fur companies, wrote an article describing what he had seen here and had it printed in a Buffalo (N. Y.) paper. It was copied by a Mormon paper in Illinois and later became well known, tho the name of the author was lost until 1900 when it was recovered through the efforts of the late Mr. Olin D. Wheeler of St. Paul.

Attention to the Mormon migration, the waning of the fur business, and the search for gold seem to have taken attention away from the Park area. In 1859 a detach-

ment of soldiers was ordered to take a look at this locality. As the officer in charge was to observe an eclipse of the sun from some point north of the Canadian boundary, he had no time to waste, so, when he encountered a heavy snow, continued toward Canada.

Then the Civil War attracted attention, so nothing was done about exploring the wonderful region until 1869, except that a goldseeker named De Lacy passed thru in 1863. The Park has a creek which bears his name.

In 1869, several important people of Montana organized an expedition to test the truth of the stories they had heard. An Indian scare caused all of the party except three men: Cook, Folsom and Peterson, to withdraw. These three men returned with such stories that the Washburn-Doane expedition was organized.

Washburn was surveyor-general of Montana, Doane was the lieutenant in charge of the military escort. In the party were prominent men; Langford, Everts, and Hedges, to name some. That expedition of 1870 visited practically everything of interest on the present loop road system except Mammoth Hot Springs. In this section, it might be of interest to know that the Beehive, the Castle and Old Faithful geysers were named by the Washburn-Doane party. It was, as a result of the efforts of these men; writing, lecturing and lobbying at Washington, that this area was set aside, "For the benefit and enjoyment of the people" by an act of Congress, signed by President Grant on March 1, 1872.

The Hayden party remains to be mentioned. It was under Dr. Hayden, head of the United States Geological Survey. It consisted of scientists and accurate observations were made; the height to which the geysers played, their intervals, etc.

I am frequently asked how the Park got its name. It was named for the river which got its name many years ago. At first the Indians called it "Mi tsi a da zi" which means Rock Yellow River. The French trappers and traders who next came in called it the Pierre Jaune or Roche Jaune, Yellow Stone or Yellow Rock, and established - usage has finally written it Yellowstone.

In conclusion, let me call your attention to our eighteen other national parks, each of which is distinctive. You will find in them objects of interest you will not find here, just as you find things here to be found in no other. All the national parks are in the charge of the National Park Service, a bureau of the Department of the Interior. The rangers are to protect the parks for the enjoyment of all, and to be of service to the visitors. This talk is one evidence of the latter.

HISTORY OF THE YELLOWSTONE LAKE

By Charles Phillips
1890 - 1927

To many tourists-Yellowstone Lake comes as a welcome lull in the almost continuous excitement of the four and a half day tour, a brief relaxation from the high emotional pitch that the wierdness and wonder of the engender in responsive natures. Yet beneath its tranquillity and sylvan peace lies the record of a story scarcely less stirring that that of the volcanic area.

Yellowstone Lake, like most of the lakes in northern United States, is a child of the ice age. The Park was not covered by the continental ice sheet but rather by an ice cap formed of the amalgamated glaciers that moved down from the mountains. For this reason the movement of the ice in this region was not in a general north-and-south trend as on the Great Plains but in a variety of directions determined by the topography of the country. One ice stream coming down the present Upper Yellowstone carved out the broad rounded valley occupied by that stream and the Southeast Arm and probably excavated part of the depression now filled by Yellowstone Lake. Another glacier from the northern Absarokas gouged out the valley of the Lamar and the Yellowstone River below Junction Butte. This glacier eventually advanced to a point just south of Livingston. Smaller glaciers descended the slopes of Mt. Washburn mingling with the general ice sheet at its base. There was at this time no vestige of a canyon; the broad, rolling upland plains on each side of the present river had not yet been divided by the deep gash that now separates them.

When a more genial climate finally prevailed again and the ice streams began to melt back toward their sources, huge volumes of water accumulated in the lowlands and a great lake developed that filled the basin of the Yellowstone Lake and Hayden Valley with arms extending up the Pelican Creek and Upper Yellowstone valleys. The natural outlet of this lake would have been the old pre-glacial channel at Outlet Canyon south of the lake but this was still blocked by the ice cap on Chicken Ridge and the water rose to the 8000 foot level, overflwing at several points; at Grebe Lake and thence down the course of the present Gibbon; at Mary Mt. and down the present Nez Perce Creek; and from the Thumb down the route of the auto road to Lewis Lake and River. This drainage was, in a comparative sense, only temporary for Outlet Canyon was presently cleared of ice and established itself as the permanent outlet, bringing the lake down to 7900 feet.

This, then, was the glacial Lake Yellowstone that was probably older at its death than the present lake is now. It stood 160 feet higher than the water-level today and its area was 310 square miles as compared with the 139 square miles of the Lake that we now know. The glacial lake was in reality double, the upper lake covering Hayden Valley and washing the base of Mt. Washburn, the lower lake occupying the basin of the lake today with arms reaching up into Pelican Valley and the Upper Yellowstone. The "Narrows" occurred at the rapids where the Yellowstone River makes a right angled turn to the west about three miles below the Fishing Bridge. This huge body of water drained thru Outlet Canyon into Heart River and thence by way of the Snake and Columbia into the Pacific. The Continental Divide at that time passed over Mt. Washburn, extending southeastward over Pelican Cone and down the crest of the Absarokas.

The records that bring the story of the lake down to this point are so clear that one does not need to be a geologist to read them. The topography of Hayden Valley with its meandering, ex-bowed streams indicate even to the casual observer that it was recently a lake bottom while the terraces at Terrace Point show as unmistakably the several levels at which the lake stood at different stages of its history. How the drainage shifted northward is still, however, a mooted question. Many explanations have been offered but none seems more plausible and surely none is more dramatic than that suggested by Dr. J. Paul Goode. (Bulletin of the American Bureau of Geography Volume 11 Number 2, June 1901 - "The Piracy of the Yellowstone" - J. Paul Goode).

The Lamar was a great river in those days fed by the ice sheets that still covered the mountains. While there was no Yellowstone River the stream whose remnant we call Broad Creek had cut a large canyon which had been further enlarged below Tower Fall by the stream that antedated the present Tower Creek. Sulphur Creek, probably larger than it is today but still a small stream, flowed down

the southeast flank of Mt. Washburn. It would have naturally drained into Glacial Lake Yellowstone but a slight obstruction diverted it to the north and it found its way into the canyon of the ancient Broad Creek where that stream turned sharply northward (i.e. at the mouth of the present Broad Creek).

Since the close of the volcanic era the surface in this region has been acted upon by the steam and gases from the heated areas below, decomposing them and reducing them to a clay like texture. These soft, disintegrated rocks were easily cut by so small a stream even as Sulphur Creek and before long the gulch of the creek was undermining the low bank that held back the waters of the great lake. Once breached an ever increasing volume of water roared down the little gully and into Broad Creek which now became the tributary and the new river in Sulphur Creek canyon the main stream. Even today the similarity between the Grand Canyon below the junction with Broad Creek and the canyon of the latter stream is unmistakable.

With two outlets the level of the lake dropped rapidly. Shortly the surface of the water fell below the altitude of Outlet Canyon and the entire drainage was through the north outlet. This is one of the most extensive examples of such a change of drainage known and the only one where the flow was shifted over the Continental Divide.

At 7800 feet the lowering was checked by a zone of hard rhyolite, unchanged by thermal decays. The decomposed material had heretofore not presented sufficient resistance to the stream to develop a cataract, in fact, the Canyon has not been cut by the recession of a waterfall as have the gorges at Niagara or the Mississippi at St. Anthony, but rather by the continuous action of a long, unbroken series of rapids. Now, however, as this wall of resistant rock came to light a true cataract appeared which rapidly deepened as the increasing fall of water wore away the clayey substance below. The passage through this zone forms the present lower fall.

The check offered by this barrier halted the formerly rapid lowering of the lake and a series of beaches show that it remained at this level for some time. Finally the tremendous erosive power of a stream that must have been many times larger than the present river prevailed and the lake began slowly dropping again. Presently another resistant zone was met less than half a mile above the first. Here the process was repeated and the drop over this second ledge is today known as the Upper Fall. When the stream had cut out a passage through the upper wall the gradual falling of the waters above was resumed and continued without interruption until a third resistant region was uncovered.

This was the "Narrows" of the glacial lake, i. e. at the rapids a few miles below the present outlet, and it held back the waters of the lake above until the Hayden Valley was completely drained through the gaps that had been by this time cut in the two lower ledges.

This left Yellowstone Lake and River and Canyon as we see them today. The process is still going on but at an indefinitely slower rate for the volume of the present river is a mere fraction of the river that carved the Canyon. Still, it is not difficult to foretell what their future evolution will be if the river retains even its present comparatively weak erosive power. The hard rock supporting both the Lower and Upper Falls will be cut through eventually and in its place we will have a series of rapids and cascades as the river eats its way through the sand and silt of Hayden Valley. The rock at the rapids will resist erosion while ths softer material in the river-bed below is being carried away, the water falling over the unchanged rhyolite in a cataract of constantly growing height. Presently we shall have another Falls of the Yellowstone, this time (unless an unforeseen ledge comes to light) a single fall and twelve miles above the falls of today.

The fish life of the lake offers a situation no less unique than its change of drainage and which in a way parallels it. Yellowstone Park is a volcanic plateau several thousand feet above the surrounding region and every stream that flows out of the Park has one or more falls in its course that carry it down to the lower elevation. For that reason the Park waters were barren of fish life

until stocked by the Bureau of Fisheries after the creation of the National Park. The earliest explorers, however, noted that the Yellowstone Lake and River, both above and below the falls, abounded in a species of trout. This exception long remained inexplicable, assuming that the fish had reached the head-waters of the Yellowstone, as they normally would, from its lower reaches for of all the cataracts in the Park the falls of the Yellowstone would obviously be least surmountable. When it was observed that the fish were practically identical with the cut-throat trout of the Pacific slope an explanation was sought in other quarters. More thorough explanation revealed the fact that at Two-Ocean Pass, south of the Park, the headwaters of the Yellowstone mingled with those of the Snake River of the Pacific drainage in a grassy alpine meadow on which the water often stands deep enough in spring, when the trout ascend their native streams to spawn, for the fish to cross from one side of the Divide to the other. This explanation was afterward verified by Dr. David Starr Jordan who observed trout passing from Pacific to Atlantic Creek. Then this last episode brings the history of the Yellowstone Lake down to the present for while the first passage of fish over the Continental Divide occurred centuries ago, it is doubtlessly taking place, when local conditions make it possible, no less frequently today.

* *

ADDRESS TO NEWCOMERS AT CAMP ROOSEVELT

By Dr. H. S. Conard,

Ex-Chief Ranger Naturalist.

Approved by:
Superintendent Horace M. Albright,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum,
Mr. E. J. Sawyer, Yellowstone Park Naturalist.

It is my pleasure and privelege to welcome you in behalf of the National Park Service and to do all that I can to help you to do what you want to do and to see what you want to see while you are here. There are so many things to do and see about Camp Roosevelt that I will run over some of them now. You can then plan your stay to the best advantage.

In the first place this is the place where the volcanic origin of the Park can most clearly be seen. Right back of us is one of the big volcanoes that did it. Prospect Mountain, directly back of the Camp, 3500 feet high, is a part of the rim of the crater. This was a huge crater, fifteen miles across. From Prospect Peak the ring of the crater can be seen even better than from Mount Washburn. Standing on Prospect, we see Mt. Washburn, 10,317 feet, then Dunraven Peak, Hedges Peak, Observation, Cook and Folsom, making a great amphitheatre; the old crater. The rim is broken down at the northeast corner and Tower Creek flows out, draining the crater. In fact when you come through Dunraven Pass you enter the old crater. The last lava flows form this crater from the basaltic clowns on both sides of the lower canyon at Overhanging Cliff just below Tower Fall. On the walls of the Canyon you see other flows of basalt, forming layers of columns. And between these the layers of volcanic gravel thrown out by explosive eruptions of the old volcano. Of the six hundred feet of canyon wall, you saw that only a portion was made of lava flows. The most of the height is volcanic gravels or breccias.

When these gravels were being deposited from time to time, ample forests grew on the slopes of the volcano. Frequently such a forest was buried in gravel and boiling mud, and this has given our petrified trees, which are so abundant in this region. The Petrified Tree, the one on the post cards, is just two miles west of us, near the main road. It is fenced around to keep a certain class of tourist from carrying it away piecemeal. One very fine specimen that once stood on that same hillside has already been carried away. It is plain, therefore, that unless folks can remember that there are hundreds of thousands of visitors to follow them, there will soon be no Yellowstone Park to visit. We

ask your cooperation in the protection and preservation of all of the strange and beautiful things of the Park. You see the reason.

Seven miles east, along the trail, is the famous petrified forest of Specimen Ridge. Here the most casual visitor sees from eight to twelve layers of petrified trees, one above the other. You see at the top of the hill a huge petrified Sequoia stump, almost identical with the coast redwood of today. On the cliff you see that the layers of the rock are horizontal, - layers of volcanic gravel. Fifty feet below, on a lower level, stand two petrified pines, twelve feet tall and two or three feet in diameter. All of these show the petrified roots in the petrified soil just as they grew five million years ago. What has happened ? Obviously the lowest layer of trees grew first. Then came an eruption of this volcano behind us and buried the forest in hot mud and gravel. Later another forest grew on the ruins of the first. Then this was buried by an eruption. And so on for as many layers as you can count. They were cooked in hot volcanic water for a million years or so, until every molecule was replaced molecule by molecule with silica - sand - quartz. The washing out of the river valley exposed the trunks that we now see. How many trunks lie buried in the mountains no one can tell. Doubtless Dr. Thone is right when he says that these hills are as full of petrified trees as a cake is of raisins.

This Specimen Ridge country can only be reached with a guide. It is done by horseback, leaving camp at eight-thirty in the morning and returning at three, in time for the bus to Mammoth. The trip takes us down the Cooke City road, across the Yellowstone River, up the steep hill past huge glacial boulder to the brink of the lower canyon. We ride along the brink perfectly safe where you can look right down from horseback to the river, 600 feet below. There we see a group of boiling springs, where we sometimes cook our own dinners on nature's own stove. Thence we go on past the Overhanging Cliff, seeing the wonderful face of the cliff with its basaltic columns; then up another steep hill and out to a point where Tower Fall is seen in face view, a silent wisp of spray a mile away across the valley. On the next plateau we always find a herd of antelopes, many elk horns and occasionally a coyote. We have lunch in a little aspen grove by a stream of delicious water. After lunch we go on to the top of Specimen Ridge, from which we see the whole Lamar Valley stretched out 1500 feet below us, and a glorious horizon of mountain peaks all around; thence down to the petrified trees. We come home along the floor of the valley. The descent to the valley is one of the most gloriously scenic rides you can find anywhere in the world. In fact this whole trip is easily one of the most interesting, instructive, thrilling and scenic experiences you can get in the Park. If you have only one day, do this.

After the volcanoes and petrified trees there was a long period of relative quiet. And then came the glacial period. A great glacier swept in from the Absarokas on the east, covered this region three thousand feet or more with ice, and slid on to Mammoth. The big rocks that you see on the hills in front of us, and in our yard here were left by the glacier. They are of granite. There is no granite east of us for more than five miles. These probably came twenty miles or more. Another glacier swept into the park from the west and the two streams met at Mammoth. There they met and flowed northward thru the canyons of the Gardiner and Yellowstone rivers out toward Livingston. They left a huge hill of gravel at Mammoth known as Capitol Hill. Strange to say this hill rests on hot springs deposit. And what does this mean ? It means that the hot springs had been in eruption a long time before the glaciers came, that they had already built up a huge amount of deposit, and that the glacier rode over the hot springs and never put them out. They seem to be running just about the same as ever.

How long ago was it ? Well, the Scandinavian geologist De Geer has calculated very accurately that it is about 12,500 years since the last ice sheet melted off of the latitude of Christiania. And American geologists think that the Grand Canyon of the Yellowstone has been cut in post glacial times and in about 12,000 years. Iowa geologists consider - and I have examined some of their evidence and am inclined to accept their conclusions - Iowa geologists estimate the whole glacial period in Iowa as about 600,000 years. So it may fairly safely be said that the Mammoth Hot Springs are about a million years old. And the petrified trees about five million. The volcano was active during the Miocene Age of geologists. It may have been active off and on for a few million years. All of this, and many more things, can be read - a child can read - in the hills of Camp Roosevelt.

ADDRESS TO NEWCOMERS AT CAMP ROOSEVELT Conard

Leaving geology, this is the best place in the park to see birds. Some folks say there are not many birds in the Park at best. It is true that coniferous or evergreen forests harbor fewer birds than deciduous forests. But at daybreak in this region, especially in the early part of the season, there is a fine chorus of bird songs. The robin, western bluebird, pinksided junco and mountain chickadee are abundant. The redshafted flicker - red beneath where the eastern one is yellow, and a very handsome fellow - is common. Crows, ravens, red tailed hawks and camp robbers are the larger birds. In a lake beyond Junction Butte yonder, seen on the way home from Specimen Ridge, is a colony of yellowheaded blackbirds, the only colony in the Park. At every waterfall there is an ousel nest. This little bird walks under water where it is so swift that you or I couldn't possibly stand. It has been made famous by the writings of John Muir. Many other birds live about here.

And this is headquarters for seeing the wild animals of the Park. Twelve miles up the Cooke City Road is the Buffalo Ranch. But you cannot see any buffaloes there. The Lamar herd of about 800 is out in the mountains eastward, out of harm's way. It is best so. They are dangerous animals. You can see a dozen or so in a sagebrush corral at Mammoth, with all of the benefits of strong fence between them and you. That is the only place to see the buffaloes. The next biggest animal is the moose. We occasionally see one or two on the trips to the beaver dams in the evening. There are many elk in this region, but at this season they are up in the mountains over 8000 feet. If you are well seasoned in mountain climbing we can climb Peospect Mountain and take a chance of seeing elk. Sometimes we see as many as fifty and sometimes none.

Mountain sheep spend their summers above 9,000 feet. So the place for them is on Mt. Washburn. If you didn't see any on the way over, you have missed your chance. Deer are frequent, but they wander about alone, or a mother with a fawn or two, and we never know where to find them. Out on the hill in front of us, and on over toward Garnet Mountain is the antelope pasture. Out there we nearly always find a herd of antelopes. We can go over to them in the morning if you like. The bears are abundant all around the building and at the kitchen door. They are tame, but do not take any liberties with them. It is wise not to feed them from the hand. Accidents happen every day to tourists who take undue liberties. We feel that the accidents are due to carelessness on the part of the people, and the bears are practically never to blame. Even a tame bear is a wild animal. Act accordingly.

Now if I have omitted just the thing you wanted to have me tell you about, please ask questions. Buttonhole me anywhere and at any time. Ranger service is always free, and we want to be of use to you. At ten minutes to seven I will be back here to go with any who want to go to the beaver dams to see the beavers swim about. The place is about two miles away and along the auto road. We go over and sit on the bank quietly and watch. So far the beavers have never failed to put on a show every evening. It is different every time. We never know what they will do, but they will do something. We get back from this about nine to nine-thirty. Tomorrow morning at 8:30 I will be here to go on a hike with anyone who will go with me, and we will go wherever you want to go. It is all interesting to me. We can go out to the antelope pasture and down to the old Yancey Ranch to see the conies, or over the hill to Lost Creek and Lost Lake for flowers and trees and beaver dams, or into the lower canyon to see the hot springs and on to Overhanging Cliff to see the lava flow and back over the scout trail through the flower gardens, or to Junction Butte, or anywhere else. See you at six fifty.

ADDRESS TO NEWCOMERS AT CAMP ROOSEVELT
(Longer Talk)

By Dr. H. S. Conard,
Ex-Chief Ranger Naturalist

It is my pleasure and privelege to welcome you in behalf of the Department of the Interior and to do all that I can to help you to do what you want to do and see what you want to see while you are here. There are so many things to do and see while you are here at Camp Roosevelt that I will run over some of them now. You can then plan your stay to the best advantage.

By all odds, the most interesting, instructive and thrilling experience here is the horseback trip over Specimen Ridge. This starts in front of this building at 8:30 in the morning, returning by three in the afternoon, in time for the bus for Mammoth. The whole distance is about 14 miles; the horses are safe, and anyone can go. We go out along the Cooke City Road, across the Yellowstone River, up a steep hill past a huge glacial boulder, to the brink of the lower canyon. We ride along the brink where you can look right down from horseback to the river 600 feet below. You don't have to ride that close if you don't like it. There is all outdoors on the other side. We see a group of boiling springs and steam holes beside the river, where we sometimes go to cook our dinner on nature's own stove. Thence we go on past the overhanging cliff, seeing the wonderful face of the cliff with its basaltic columns. This takes us right along the top of the row of columns you saw across the river just this side of Tower Fall. Then we go up another steep hill and out along the canyon where we get a front view of Tower Fall, a silent wisp of spray a mile away across the valley.

On the next plateau we always find a herd of antelopes, many elk horns, and occasionally a coyote. We follow the antelopes as long as we have time, and then stop for lunch in a little aspen grove beside a stream of delicious water. After lunch we go to the top of Specimen Ridge, from which we see the whole Lamar Valley stretched out 1500 feet below us, and a glorious horizon of mountain peaks all around. On the way up we see pieces of petrified wood. We go down over the brow of the hill a couple of hundred feet and dismount for the famous petrified forest. Here we pass along a narrow path beside a stump of petrified sycamore, and out on the side of a very high, steep slope, dotted with standing trunks of petrified trees. The first is a huge stump of Sequoia, almost identical with the coast redwood. This stump is six feet in diameter and eight feet tall. When you go below it you will find the petrified roots in the petrified soil, just as it grew 5 million years ago. Fifty feet below this stand two magnificent trunks of petrified pine, also on their own roots. If you will walk down the hill the most inexperienced person will find eleven or twelve successive layers of fossilized forests. We look at the hillside and see the rock strata - the soils on which the trees grew - lie horizontally. They grew on approximately level ground, and we are looking at a whole series of forests, that grew in succession, the upper ones on the ruins of the lower. The rock between is volcanic gravel and mud. A moment's thought shows anyone that what happened is this: the big volcano just behind us had forests growing on its flanks, just as is the case with modern volcanoes. Then came an eruption and buried the forest in a bed of gravel and mud. Things were quiet for a long time at least in that region, and another forest grew up. This then was buried. And so on for a dozen layers. Then they were all cooked in geyser water for a million years or more, until all the wood was gradually dissolved out and replaced molecule by molecule with silica - stone. Then the hillside was washed out by the river and the trees were exposed to view for us to see. The preservation of the wood is often very perfect. You can easily count the ages of the trees by the rings in the wood, just as in modern trees.

From the petrified forest we ride down the hill with the most glorious mountains and valleys below us, a thrilling scenic ride, past more petrified trees, past Crystal Creek where we get another cold drink, and down into the Lamar Valley. Here we often see more antelopes. Coming past Bird Lake we see the yellow-headed blackbird, one of the two colonies of this handsome bird in the park. Those of you who live in Wisconsin or from there to Utah know this species already. Returning north of Junction Butte, we us usually stop at Icy Spring, the coldest water that comes out of the ground. Thus, on the trip we see more geology, more wild animals, more flowers, and more sublime scenery than on any other trip in the Yellowstone and some say, in the world. It is our best offering. A wrangler goes on the trip as guide. On occasions a ranger naturalist goes too.

ADDRESS TO NEWCOMERS AT CAMP ROOSEVELT (Longer Talk) Conard

If you do not care for so stremuous trip tomorrow, there are several fine hikes on which I would like to have some playmates. If you want to see some antelopes, we will go out to the grassy hill in the front of us and work along toward Garnet Mountain until we meet them. We rarely fail to find a bunch. They are easily the most dainty and beautiful of the wild animals of the Park. The little ones of this years crop are simply charming. We can go on over to Garnet Mountain if you like, just for a climb, and to see the crude garnets that crowd the rock, just as they do in the similar mica schists of Manhattan Island and in the region of Philadelphia. Or we can go down a wild canyon past some exquisite glacial lakes to the rock slides near the old Yancey Ranch. Here we will see the cony or rock rabbit, a dainty little rabbit just as big as your fist; a colony of cliff swallows with their jug shaped mud nests plastered on the overhanging rocks; past the historic Yancey Ranch buildings and back in time for dinner.

For birds and flowers we can go up the hill eastward, past the old Boy's School, over the hill and thru the flower gardens to the brink of Lost Creek canyon just behind this camp, up the creek to the big beaver dams, and perhaps see into an old deserted beaver house, over to Lost Lake and back for dinner.

Practically no one ever sees the Overhanging Cliff properly on the way over here from Tower Fall. We might go over there. The best trip takes us up the road, while the dew is still on the grass. About a mile up we can turn into the canyon and go down to where the sulphur holes and hot springs are found. We can just see how the rock is cooked into clay by hot vapors. This is a set of little thermal phenomena, man size, so we can play with them as we like. Coming out of the canyon we go on up to the Overhanging Cliff, past the big needle. At the Cliff we can see just how the great lava flows poured down over the landscape, covering up everything in its way, and cooking the surface of the ground into ashen form. We can follow this layer of rock-form all along the roadside under the basaltic columns. Beneath this form layer we find an unmistakable river gravel and river sands, so plain that a child can see what has happened. Evidently there was a river along the flank of the . . old volcano, and this eruption buried the river and put it out of business forever. What was the river and where did it come from and where did it go ? There are pebbles in the gravel that do not look like anything from this region. We are waiting for some geologist to come in and explain it.

From Overhanging Cliff we come home over a trail made by the boy scouts, thru two miles of the most glorious flower gardens one could desire and back to the camp for dinner. One day a lady kept track of the flowers on this trail and counted 42 kinds.

If you are a seasoned mountaineer and want to see elk we can take an all day hike to the summit of Prospect Peak just back of the Camp, and 3,000 feet above us. Total height 9,300 feet. This is a long, hard climb; there is no trail, we just go up. At about 8,000 to 9,000 feet we see the female elk and calves. Failing that we may see some bull elk at the top. And sometimes we miss them entirely. The flower gardens on the way and the alpine marsh near the summit are wonderfully rich for the botanist. We should leave by eight thirty and cannot be back before five in the afternoon. It is hard work even for the seasoned climber, but glorious and I would like to go.

Then there is Junction Butte from which you can see all of the region beyond, the beaver dams near Yancey's, and so on and so on.

This evening after supper we will go over to the beaver dams by the Petrified Tree, two miles up the auto road, and sit on the bank and watch the beavers swim about. Some people say they watch the beavers work. I only say swim. We cannot hope to see them building dams or houses. But so far they have never failed to come out and put on some kind of a show. It is different every night. I will be glad to go over with anyone who wishes to go. We leave here at ten minutes to seven and get back at about nine fifteen. It is 2 or 2½ miles each way on a good road.

Now if I have left unsaid just exactly the things you wanted me to say, please be free to ask questions, and I will try to answer them, Yes, there is lots of good fishing. You can get fish almost anywhere if you know how. Generally speaking the nearer places are fished out first. Personally I do not fish and dont know nor care anything about it. Ask the fishing guide at the camp.

ADDRESS TO NEWCOMERS AT CAMP ROOSEVELT (Longer Talk) Conard

For further information about many things you can get the government pamphlets at the desk for ten cents each, one on the petrified forests, one on geysers, one on geological history. At the information office at Mammoth you can get many other publications. For flowers and trees you should have Thone's little book, Trees and Flowers of the Yellowstone. For general information get Chittenden's History of Yellowstone Park, Skinner's Natural History or Bear Book. And please use the ranger service in any way that you can. This service is absolutely free. You are our guests.

That's the dinner call - and I must be after mine too. See you at 5:50.

* * * * * * * * * * * * * * * * * *

NOTES ON THE FOSSIL PLANTS IN THE REGION OF CAMP ROOSEVELT

By Dr. Ralph W. Chaney, Research Associate,
Carnegie Institute of Washington

Approved by:
Superintendent Horace M. Albright,
Dr. H. S. Conard, Ex-Chief Ranger Naturalist,
Mr. J. E. Haynes, Acting Director, Yellowstone Park Museum.

The fossil forests of Yellowstone National Park are the most magnificent on the continent. Added to their spectacular beauty is the story they tell of the world of yesterday, when the Yellowstone region as we know it was taking form. Looking back into the past, we can read much of this story of the ancient days before man lived upon the earth. For while the written documents which we associate with human history are lacking, there is yet a singularly complete chronicle of past events in the rocks and in the fossils buried with them. We may well consider why the record of former plant life is so exceptionally well preserved in Yellowstone Park. Most of the trees of today, - trunks, branches and leaves, - decay and fall to pieces shortly after death, leaving after a few years little indication of their existence. But some of the trees which lived here four or five million years ago still stand on the rocky slopes of the valley of the Lamar River; the winter snows drift over their roots; birds and bees fly about them on warm summer days; and we, climbing the side of Specimen Ridge or the hills west of Camp Roosevelt, may almost mistake these ancient giants for the stumps of recently living trees until we touch them, and find they are of stone. They owe their endurance through the ages to a process called petrification, which means "making into rock".

The first requisite for petrification is rapid burial, for unless a tree is covered almost immediately the wood will decay. In ages past during the period called the Tertiary, there were several great volcanoes in the Yellowstone region, one of which was located not far south of Camp Roosevelt. In addition to pouring out lava flows over the adjacent country, this volcano had periods of explosive activity during which great volumes of rock were blown into bits by steam and scattered on the slopes below. Thus it came about that the forests of the region near the volcano were buried in this pyroclastic material (clastic means broken, and pyro - by fire). The tops of the trees, which remained uncovered, have decayed or burned, but the stumps were protected by the gradually solidifying mantle of volcanic ash which inclosed them. At various places another forest has grown on the volcanic ash and in turn has been destroyed by another volcanic eruption; at Specimen Ridge more than twelve such forest layers can be seen, representing alternating periods of tree growths and destruction.

The second stage in the process of petrification was also associated with vulcanism, involving the circulation of hot volcanic waters through the pyroclastic rocks and the buried tree stumps. These waters gradually dissolved away the wood, leaving in its place a mineral known as silica. So slowly was this interchange of material effected that the detailed cell structure and annual rings of the wood are commonly preserved. There is no evidence that the process of petrification is in any way connected with the geysers. Stumps and wood fragments submerged in geyser waters may become incrusted with mineral matter, but the wood itself is not known to be changed into rock except where it is buried.

NOTES ON THE FOSSIL PLANTS IN THE REGION OF CAMP ROOSEVELT Chaney

A third stage in the development of the petrified forests as we know them involved the uncovering of the stumps. Rain and wind through the centuries have worn away the comparatively soft volcanic ash, but the wood replaced by silica - silicified wood - has resisted the process of erosion, since silica is one of the hardest of the common minerals. As a result these trees remain, - sequoias, pines and sycamores, - their roots still fixed in the ground, their tall stems rising toward the sky, just as if thousands of centuries had not passed since their branches swayed in the wind and the birds of an ancient Yellowstone summer chose them for nesting places.

Around the roots of these old trees, in the rock which was once the soil of the forest, a careful search may disclose the impressions of leaves. The leaf itself is not present, since so delicate a structure is rarely petrified. But the print in the fine volcanic ash shows the shape and nervation, and enables us to recognize such species as the chestnut, now living only in the eastern United States, the sycamore which ranges into the Middle West, and the sequoia of the Pacific coast. None of these are found today within many hundred miles of Yellowstone Park. They are for the most part trees which live at lower altitudes and under conditions of higher temperature and rainfall than now obtain here. The element of change is apparent, as it is in the study of earth history everywhere. And if the Yellowstone as we know it is different from that of four million years ago, when showers of volcanic ash covered the forests of sequoia, pine, chestnut and sycamore, preserving them down through the ages for our pleasure and instruction, may we not expect that the Yellowstone of four million years hence will likewise present a new appearance ? There may even be left in the rocks a record of our activities here which will tell future visitors to Yellowstone Park the story of the life and living conditions of our time.

II 166

Complimentary Copy

READING UP ON THE YELLOWSTONE

Reprinted from the Sierra Club Bulletin, Vol. XII., No. 3, 1926, through the Courtesy of the author.

Francis P. Farquhar
Editor, Sierra Club Bulletin

The most important of all the Books, Maps, Magazine Articles and Government Reports on Yellowstone National Park.

Special Publication of

HAYNES PICTURE SHOPS INC.

Official Photographers of
Yellowstone National Park

Yellowstone Park, Wyoming · St. Paul, Minnesota

1186

The seven books and map listed below, may be obtained at all of the fourteen Haynes Picture Shops in the park, or by mail from:

HAYNES PICTURE SHOPS, INC.
YELLOWSTONE PARK, WYOMING
OR
341-5 SELBY AVE., ST. PAUL, MINNESOTA

The Yellowstone National Park: Historical and Descriptive. By Hiram Martin Chittenden. 356 pages, illustrated, and large map. (J. E. Haynes, publisher.)

Silk Cloth Library Binding.....$2.50 (*Postpaid* $2.80.)

Haynes Guide of Yellowstone National Park: Haynes New Guide and Motorists' Complete Road Log. By J. E. Haynes, 192 pages, illustrated, and folder map. (J. E. Haynes, publisher.) Two bindings.

De Luxe Binding .....$1.50 (*Postpaid* $1.70)

Poster Cover ..... .75 (*Postpaid* .90)

Trees and Flowers of Yellowstone National Park. By Frank E. A. Thone. 70 pages, illustrated. (J. E. Haynes, publisher.) Two bindings.

De Luxe Binding .....$1.25 (*Postpaid* $1.45)

Poster Cover ..... .75 (*Postpaid* .90)

Maw's Vacation—A Human Being in the Yellowstone. By Emerson Hough. 62 pages, illustrated. A Saturday Evening Post Story. (J. E. Haynes, publisher.)

Poster Cover .....$ .75 (*Postpaid* $ .90)

The Discovery of Yellowstone Park—1870. By Nathaniel Pitt Langford. 188 pages, illustrated with sketches, maps and portraits—47 in all. (J. E. Haynes, publisher.) Two bindings.

De Luxe Binding .....$1.50 (*Postpaid* $1.70)

Poster Cover ..... .75 (*Postpaid* .95)

Foolish Questions: Yellowstone's Best. By Jack Chaney. 104 pages, illustrated. (J. E. Haynes, publisher.)

Poster Cover .....$ .50 (*Postpaid* $ .60)

National Parks Portfolio. By Robert Sterling Yard. 248 pages, including 306 illustrations.

Bound in cloth. Price.....$1.00 (*Postpaid* $1.25)

Map of Yellowstone National Park. Size 28½x32 inches; scale, two miles to the inch.

Price .....$ .25 (*Postpaid* $ .35)

(*Prices effective for 1927; subject to change thereafter*).

READING UP ON THE YELLOWSTONE

By Francis P. Farquhar

THE Yellowstone National Park is almost like a foreign country upon a first visit. It is full of strange and remarkable things—a vast museum with countless objects calling for explanation. There are so many astonishing sights on either hand that one is inclined to forget that just beyond, in the great back-country of the park, are still more wonders and even grander scenes than those along the beaten path. There is, moreover, a human history of the region, which, while brief as such things go, is nevertheless full of interesting episodes and many vivid characters. It is a good plan, therefore, to frequent libraries and bookstores before making a trip to the park.

For the benefit of those who may desire to go prepared with some definite knowledge of what to expect and a general background for their observations, the following lists are presented. They do not purport to be a complete bibliography, but for all ordinary purposes they should serve as a sufficient field from which to make selections. The first two sections comprise a well-balanced and easily obtainable library on the Yellowstone National Park. The supplementary lists contain a wide range of publications offering profitable and enjoyable reading. Most of the volumes can be found in the larger libraries, although a number are out of print. A few are much harder to find, but are included because of their interest or historical importance.

A.—GOVERNMENT PUBLICATIONS

The first thing to do in reading up on the Yellowstone is to obtain the current government publications. Write to the *Director of the National Park Service, Department of the Interior, Washington, D. C.*, for the following:

1. *Rules and Regulations, Yellowstone National Park.* (Latest annual.) Free.
2. *Motorists' Guide—Yellowstone National Park.* Free.

Next, write to the *Superintendent of Documents, Government Printing Office, Washington, D. C.*, sending remittance by post-office money order, for the following:

3. *Geological History of Yellowstone National Park.* By Arnold Hague. 24 pages, illustrated. Price, 10 cents.
4. *Geysers of Yellowstone National Park.* By Walter Harvey Weed. 32 pages, illustrated. Price, 10 cents.
5. *Fossil Forests of the Yellowstone National Park.* By F. H. Knowlton. 32 pages, illustrated. Price, 10 cents.
6. *Fishes of the Yellowstone National Park.* By Hugh M. Smith and W. C. Kendall. (Bureau of Fisheries Document 904.) 30 pages, illustrated. Price, 5 cents.
7. *Panoramic View of Yellowstone National Park.* (Map, 18 by 21 inches.) Price, 25 cents.

At the same time it would be well worth while to order from the Superintendent of Documents a book that contains a number of fine illustrations of Yellowstone as well as of all the national parks:

8. *National Parks Portfolio.* By Robert Sterling Yard. 248 pages, including 306 illustrations. Bound in cloth. Price, $1.00.

Maps can be purchased from the *Director of the U. S. Geological Survey, Washington, D. C.*, or may be obtained from local dealers at a small advance over the government price. Of the following, the large map of the entire park is essential; the others may prove useful in providing knowledge of the adjacent region:

9. *Map of Yellowstone National Park.* Size, 28½ by 32 inches; scale, two miles to the inch. Price, 25 cents.
10. *Livingston, Crandall, Ishawooa, Mount Leidy, Grand Teton Quadrangles.* (5 sheets.) Price, 10 cents each.

B.—Leading Books on the Yellowstone

Without question, the two most important books on the Yellowstone are:

1. *The Yellowstone National Park: Historical and Descriptive.* By Hiram Martin Chittenden. 350 pages, illustrated.
2. *Haynes' New Guide and Motorists' Complete Road Log of Yellowstone National Park.* By J. E. Haynes. 192 pages, illustrated.

If not found locally, these books can be ordered from J. E. Haynes, Selby and Virginia avenues, St. Paul, Minnesota.

General Chittenden's book was first issued in 1895 and has gone through several editions. It is well composed, and is the most complete and authoritative book on the park. The early history of the region affords many fascinating tales: the thrilling adventures of John Colter, the fabulous stories of Jim Bridger, the mysteries of

unknown trappers; the pursuit of hostile Indians; and the varied experiences of exploring parties. A comprehensive summary is given of the principal natural features: animals, flowers, forests, as well as the geysers, mud springs, terraces, and other curiosities.

Haynes' Guide Book is the result of many years of evolution in presenting the material in the most convenient form. It is one of the most satisfactory guide-books to be found for any part of the world, and has an advantage over most in being thoroughly illustrated with well-taken and finely reproduced photographs. Its reliability is vouched for by the National Park Service.

Next in importance among the general books dealing with the park comes:

3. *The Discovery of Yellowstone Park, 1870.* By Nathaniel Pitt Langford. 188 pages, illustrated.

This is Langford's diary of the expedition that resulted in establishing the Yellowstone National Park by act of Congress, March 1, 1872. Originally published by Langford himself in 1905, it has recently been reprinted by J. E. Haynes in uniform style with *Haynes' Guide.* The quaint sketches and early photographs of the original have been retained. The "discovery" party, composed of some of the most reputable citizens of Montana, was organized for the purpose of determining finally and positively whether there was any truth in the wild tales of spouting fountains, hot springs, mud volcanoes, and other hellish things. The leader of the party was General Henry D. Washburn, surveyor-general of Montana. Langford became, two years later, the first superintendent of the Yellowstone National Park. To Cornelius Hedges, one of the members of the party, belongs the distinction of suggesting that this marvelous region should be made a national park. Besides being an historical document of great interest, this diary is an entertaining account of an exploring expedition in which men of more than ordinary individuality came day after day upon new and unexpected features of the most astonishing character.

Another general book, found in most libraries and obtainable, is:

4. *Wonders of the Yellowstone.* Edited by James Richardson. 256 pages, illustrated.

This was first issued in 1872, and has appeared in several editions. The chapters are drawn from the official reports of government ex-

peditions and surveys by Barlow, Doane, and Hayden, and from articles contributed to *Scribner's Monthly Magazine* by Hayden, Langford, and Everts. As most of these reports and articles are now difficult of access, this book is very useful in making this material available. The chapter entitled "Thirty-seven Days of Peril" describes an adventure that received wide publicity in its day and may well be read with profit by present-day visitors who have a tendency to wander from the trail.

The scientific features of the park are covered very well by the government pamphlets already mentioned and by the references to more extensive technical works to be found therein. In the field of natural history there are several good current books dealing specifically with the Yellowstone region. They are:

5. *The Yellowstone Nature Book.* By M. P. Skinner. 1924.
6. *Trees and Flowers of Yellowstone National Park.* By Frank E. A. Thone. 1923. 70 pages, illustrated.
7. *Trees and Shrubs of Yellowstone National Park.* By P. H. Hawkins. 1924. 125 pages, illustrated.
8. *Birds of Yellowstone National Park.* By M. P. Skinner. 1925. 192 pages, illustrated.

C.—Supplementary Books on the Yellowstone

The following books deal primarily with the Yellowstone region and provide a good variety of reading supplementary to the group already mentioned. There may be some difficulty in finding the earlier ones, but a search is well worth while:

1. *The Great Divide.* By the Earl of Dunraven. 1876. (Reprinted in 1917 under title of *Hunting in the Yellowstone;* edited by Horace Kephart.)
2. *Calumet of the Coteau.* By P. W. Norris. 1884.
3. *Through the Yellowstone Park on Horseback.* By G. W. Wingate. 1886.
4. *The Passing of the Old West.* By Hal G. Evarts. 1921.
5. *Maw's Vacation—A Human Being in the Yellowstone.* By Emerson Hough. 1921.
6. *On the Trail in the Yellowstone.* By Wallace Smith. 1924.

D.—Books Containing Important Chapters or Sections Relating to the Yellowstone Region

The list of books under this heading could be expanded indefinitely, and only a representative selection is given here:

Reading Up on the Yellowstone

1. *Camp and Cabin.* By Rossiter W. Raymond. 1880.
2. *Nez Percé Joseph. History of the Nez Percé Campaign of 1877.* By General O. O. Howard. 1881.
3. *The Book of the Boone and Crockett Club.* Edited by Theodore Roosevelt and George Bird Grinnell.
4. *Vigilante Days and Ways.* By N. P. Langford. 2 vols. 1890.
5. *Our National Parks.* By John Muir. 1901.
6. *The Biography of a Grizzly.* By Ernest Thompson Seton. 1903.
7. *Wild Animals at Home.* By Ernest Thompson Seton. 1913.
8. *Your National Parks.* By Enos Mills. 1917.
9. *The Book of the National Parks.* By Robert Sterling Yard. 1919.
10. *The Cross Pull.* By Hal G. Evarts. 1920.
11. *Down the Yellowstone.* By Lewis R. Freeman. 1922.
12. *The Call of the Mountains.* By LeRoy Jeffers. 1922.

E.—Magazine Articles

Since the discovery of its wonders, in 1870, there has been a vast number of articles on the Yellowstone region in all manner of periodicals. Many of the scientific articles have appeared elsewhere in reports or books, and many of the general articles have been superseded by fuller and better accounts. Therefore, only a few of the outstanding ones are selected for this list. Some of these have been reprinted in books already listed:

1. *The Wonders of the Yellowstone.* By N. P. Langford. In *Scribner's Monthly,* vol. 2, nos. 1 and 2—May, June, 1871.
2. *Thirty-seven Days of Peril.* By Truman C. Everts. In *Scribner's Monthly,* vol. 3, no. 1—November, 1871.
3. *The Wonders of the West. More About the Yellowstone.* By F. V. Hayden. In *Scribner's Monthly,* vol. 3, no. 4—February, 1872.
4. *Ascent of Mount Hayden.* By N. P. Langford. In *Scribner's Monthly,* vol. 6, no. 2—June, 1873.
5. *The Three Tetons.* By Alice Wellington Rollins. In *Harper's New Monthly Magazine,* vol. 74—May, 1887.
6. *An Elk-Hunt at Two-Ocean Pass.* By Theodore Roosevelt. In *Century Magazine,* vol. 44—September, 1892.
7. *Yellowstone National Park Game Exploration.* A series of articles by Emerson Hough in *Forest and Stream,* May 5 to August 25, 1894.

F.—Government Reports

Most of the government reports included in the following list are out of print and are no longer to be obtained from the Superintendent of

Documents. They can usually be found in the larger libraries, however. They are valuable sources of information for those who wish to go deeply into the history and character of the park:

1. *Annual Reports of the Superintendents of the Yellowstone National Park, for 1872, 1877 to 1915.* In *Annual Reports of the Secretary of the Interior.* (Since 1915 these reports have been included in the *Annual Reports of the Director of the National Park Service.*)
2. *Annual Reports upon the Construction, Repair, and Maintenance of Roads and Bridges in the Yellowstone National Park, 1890-1918.* In *Annual Reports of the Chief of Engineers, War Department.*
3. *Exploration of the Yellowstone River in 1859-1860.* By Bvt. Brig.-Gen. W. F. Raynolds. 1868. (*40th Congress, 1st Session, Senate, Ex. Doc. No. 77.*)
4. *Geological Report of the Exploration of the Yellowstone and Missouri Rivers, 1859-1860.* By Dr. F. V. Hayden. 1869.
5. *Report of Lieutenant Gustavus C. Doane upon the So-called Yellowstone Expedition of 1870.* 1871. (*41st Congress, 3d Session, Senate, Ex. Doc. No. 51.*)
6. *An Engineer Report of a Reconnaissance of the Yellowstone River in 1871.* By Captain J. W. Barlow and Captain D. P. Heap. 1872. (*42d Congress, 2d Session, Senate, Ex. Doc. No. 66.*)
7. *Fifth Annual Report of the U. S. Geological Survey of the Territories for 1871.* By F. V. Hayden. 1872.
8. *Sixth Annual Report of the U. S. Geological Survey of the Territories, for 1872.* By F. V. Hayden, 1873.
9. *Twelfth Annual Report of the U. S. Geological Survey of the Territories, for 1878. Part II.* By F. V. Hayden. 1883.
10. *Reconnaissance of Northwestern Wyoming in 1873.* By Captain William A. Jones. 1875.
11. *Reconnoissance of the Streams and Lakes of the Yellowstone National Park, Wyoming.* By David Starr Jordan. In *Bulletin of U. S. Fish Commission,* vol. IX, for 1889.
12. *Reconnoissance of the Streams and Lakes of Western Montana and Northwestern Wyoming.* By Barton W. Evermann. In *Bulletin of U. S. Fish Commission,* vol. XI, for 1891.
13. *Geology of the Yellowstone National Park.* By Arnold Hague and others. *U. S. Geological Survey, Monograph No. XXXII,* Part II. 1899. Accompanied by Atlas.