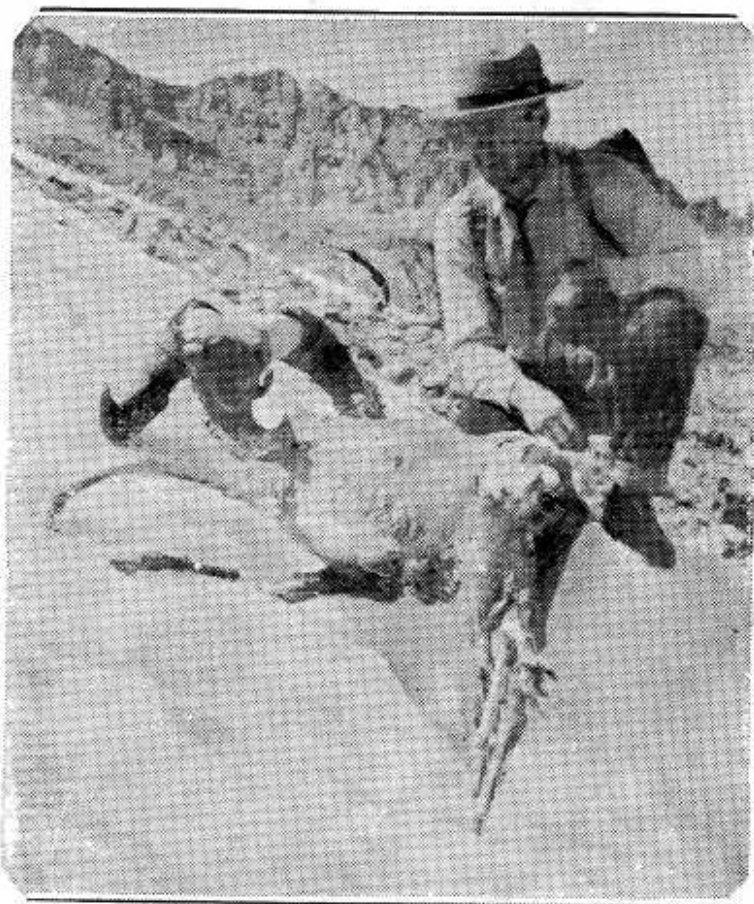


# YOSEMITE NATURE NOTES

VOL. XVII

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No. 3.



Assistant Park Naturalist Beatty with Mountain Sheep  
discovered in the Lyell Glacier on October 4, 1933.

# Yosemite Nature Notes

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## Report on the Corpse-wax in the Mountain Sheep Found in the Ice of the Lyell Glacier

By Dr. Erich Wasmund of Kiel, Germany

"In October 1933 while in Yosemite National Park I had the good fortune of being present when the rare discovery of a semi-fossil corpse of a Mountain Sheep was made and brought in from the high Sierra before it had been disturbed in any way. C. A. Harwell, the head of the small but appropriate and modernly constructed museum in Yosemite Park, and M. E. Beatty, the Assistant Park Naturalist, favored me in every way. Further I thank Dr. Joseph Grinnell, of the Museum of Vertebrate Zoology in the University of California at Berkeley, the co-worker of the faunistic monograph of the Park, for pleasant oral and written correspondence.

"The Sierra race of the Canadian Mountain Sheep belongs to the western geographic race of the wild sheep, the Big Horn Sheep (*Ovis canadensis* Shaw), which is distributed in the circum-pacific mountain ranges from northeastern

Siberia through the Rocky Mountains to Mexico. Our sub-species is extinct in the Yosemite Park region and the contiguous region at least since about the end of the last century. In 1890 the region was declared a National Park, was managed the following year by troops—but many of the protective measures came too late. The Indians with the Mountain Sheep have disappeared. One small herd still persists in the Southern High Sierra about 100 miles from the park. Restocking of the Park has been considered for long, but is not at present feasible.

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\* (Foot Note) From a translation by Carl W. Sharsmith of Dr. Wasmund's paper on "Die Bildung von anabituminous Leichenwachs unter Wasser" (The formation of early-bituminous corpse-wax under water), published in *Erdolmuttersubstanz* (Origins of petroleum), No. 10, 1935.

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'The surprising discovery of a dead Mountain Sheep with skin and hair was made on October 4, 1933, on the easterly lobe of the Mount Lyell Glacier at 12,000 feet.

'The animal weighed 45 pounds. In life it may have weighed 300 pounds. The predominant color in the Mountain Sheep is a dirty gray-brown to pale gray. The skin is indeed intact, and the somewhat shrunken-together body gives one the impression of mummification, which the condition on discovery and chemical investigation does not dispel. In mummified corpses also the soft portions are completely absent, anatomical and historical peculiarities completely disappear, and the skin lies in folds about the bones. Here, however, the form of the body is well preserved, and all deformations with the exception of the shrunken folds of the skin are due to the movements of the ice. It is considered that uniform conditions were present for preservation, since corpse-wax appears in several places, especially on the rump where it is visible through the broken skin. On the 11th of October, as I undertook a preliminary study of the recently received animal, it was still somewhat soft, more than it was subsequently. The strands of muscle were clearly visible.

'The locality of discovery is of importance in the case. The Mount Lyell Glacier in the summer of 1933 was strongly isolated and con-

siderably melted. Mr. Harwell aptly remarks concerning the condition of the ice that it was 'so melted to a honeycombed condition that it photographed white as snow.' The animal was also found on a clear summer-like day, as the illustration shows. As it was not



discovered previously and since the wandering of a stray is out of the question, this being excluded by the life-habits of the small, too distantly remote living herd, and by the evident age and condition of the fossil, it was doubtlessly melted out in the summer of 1933. With this arises the fact that the horn-shells were separated 20 and 70 feet below the body, and the right foreleg lay 30 feet in the same direction. Whether there was here a secondary dragging by some carnivore is

uncertain, but traces of any kind of devouring were absent. Greater possibility lies in the loosening of easily detached portions during the course of its being carried toward the valley in the ice, and differential transport in ice-layers of differing speeds.

“Herewith we arrive at a theory which in conversation with Mr. Harwell I find is also held by him. The animal in climbing the precipitous walls of the cirque while grazing fell from the wall and into the bergschrund, that is, into the cleft between rock and the ice of the glacier. This is evidenced particularly by the condition of the neck vertebrae the animal had apparently broken its neck by the fall, and so was killed. An injury to the vertebrae during the many years-long ice transport is unlikely; for if this had been the case, the ribs and bones of the extremities would also have been broken. Here it was snowed in the following winter. *The Mountain Sheep alternate in the winter to the scant snows of the east side of the Sierra, so that one can exclude this time of year. From here it moved downward with the ice-mass to the point where the particular layer thinned out (the point of discovery was at the lower end). The hot summer did the rest.*

The view that the animal died simply on the surface and was subsequently snowed under, and again later exposed, has little to speak for it. First there was nothing it

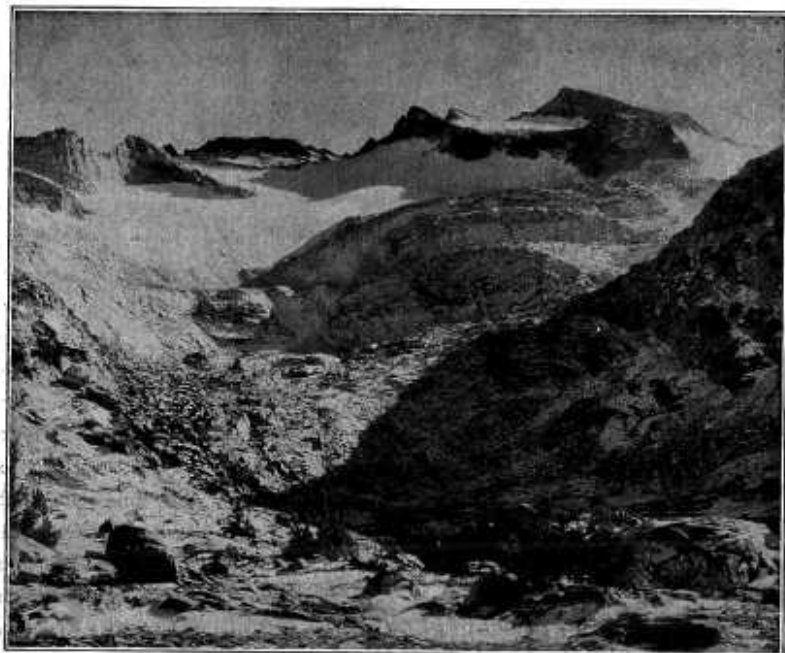
could find on the ice surface; since there is no forage. The glacier was easily circumvented above over the rocks and below over the talus and moraines. Secondly, there is the basis already given that one cannot assume that it fell into a snow-covered crevasse during a winter of heavy snow. Had it been snowed under, during the summer it would in time have worked its way to the surface, and also under a light snow-cover it would have become uncovered, and with it disintegration by decay.

Concerning the speed of motion of this glacier little is known. To this Mr. Harwell contributes that measurements of this are being carried on. The easterly lobe of the glacier begins at 1936 feet above the discovery spot. Stakes were placed in the middle of the glacier lobe and measured during a period of 4 days—from the 19th to the 23rd of October, 1933. The ice moved during this time one inch. *Ninety-one inches per year would be below the glacier speed of our Alpine glaciers. Since the point the animal fell (and herewith also the depth and lateral position of the line of flow) is unknown, and out of these limited observations there is nothing conclusive, it is only speculating if we reckon that by the unverified assumption of constant movement it required 250 years to convey the dead animal the distance from the origin of the east lobe to the discovery spot. But*

the one measurement of the speed range however gives this number. More exact investigations will follow. However, one may state that we have before us in this fossil, the sole intact representative of those Mountain Sheep which long before the coming of the white man inhabited the hunting grounds of the snowy mountains of the far west.

In the latter we have made the

acquaintance of a new facies of the preservation of a mammal reduced to waxy consistency in ice. The preserving medium speaks for conditions extensively obtaining under water, e. g., exclusion of air, constant low temperature and moisture, absence of light, etc. On the other hand such fossil finds are rare, particularly those of vertebrates."



The East Lobe of the Lyell Glacier where Mt. Sheep was Found

## Some Problems of Glacier Measuring

By C. A. Harwell, Park Naturalist

Since 1931 the Naturalist Department of Yosemite National Park has made an annual expedition approximately the first of October to make measurements, photographs,

and studies of the glaciers on Mt. Lyell, Mt. Maclure, Mt. Dana and Mt. Conness. One year, 1932, we included the glaciers on Koip and Kuna peaks.

New discoveries are made each year to add zest to the explorations and new difficulties are encountered to cause us to try to refine our measuring techniques. The glaciers are retreating not only as indicated by recession of measurable fronts but general surface levels are lowering at the rate of several feet per year. The Lyell glacier, east lobe, has melted back  $50\frac{1}{2}$  feet in the six year period covered by our measurements, the west lobe  $10\frac{1}{2}$  feet; Maclure glacier has receded 99 feet; the Dana glacier some 60 feet while the Conness glacier has shown the greatest retreat where our east-lobe station shows the front is this year 289 feet from its indicated position in 1931. Photographs, taken annually from certain fixed points easily verify the fact that these ice masses are now diminishing.

The discovery of the Mountain Sheep specimen discussed in the accompanying articles by Wasmund and Sharsmith stimulated an attempt to measure the annual rate of flow of the Lyell glacier. We wanted to establish some figure for the length of time the sheep had been entombed in ice. So far we have not been too successful. Our improvised auger would set iron stakes only three feet into the ice. Since levels established by transit measurements show the ice surface melts down some four feet each year along our line across the mid-section of the glacier, our

stakes have just naturally melted out and toppled over. A longer auger is indicated. We have one located and expect in 1938 to set longer stakes to a depth of ten or more feet. These should surely hold. A series of stakes set during November 1933 could not be found in 1934. They had melted out and were covered by eight to ten inches of fresh snow. They were found prostrate on the ice in 1935 but their positions indicated a maximum movement of four or five feet per year. The stakes were reset on the base line and a solution of red dye was poured around them to a depth of three feet. In 1936 the stakes were again prostrate but at one station the original hole filled with red dye to a depth of one foot was found. This indicated a movement of only ten inches for the glacier at this point for the year which seems unusually small. A stake was reset in this same hole and orange dye poured in. In 1937 the stakes were down and no evidence left of the red or orange dye so it was decided not to reset stakes until a longer auger could be employed in 1938.

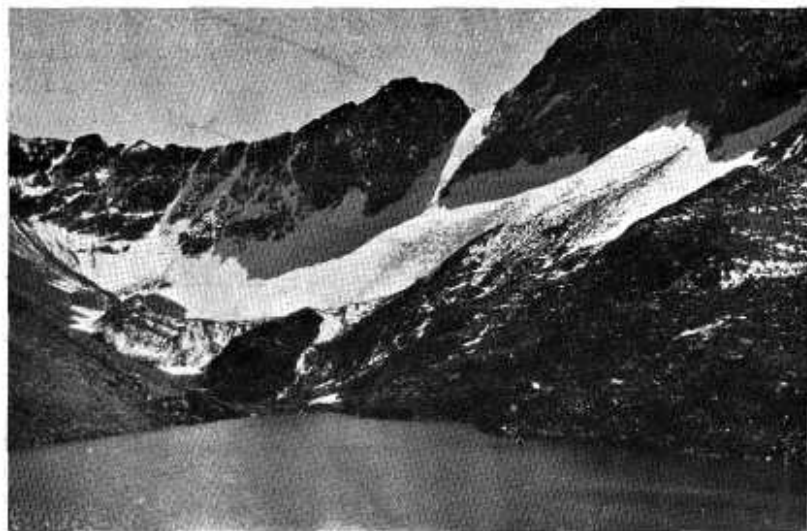
Another difficulty concerns our measuring stations. We naturally chose the point of furthest advance of each prominent ice lobe for our fronts. Of course, these "fronts" are not the actual ends of the glaciers. The terminal moraines are in reality great piles of rocks whose shade protects the



glacial ice that extends well down under them. In fact several large cave-ins produced by running water melting out channels in the shade-ice have shown the frontal moraines, especially those portions nearest the glaciers, to be just veneers of rocks overlying pure ice. The absolute fronts of the glaciers cannot be seen and so cannot be measured. Our "apparent" fronts are measurable enough, however, to be entirely worth recording. In 1938 it is our hope that the engineering department can furnish assistance in order to accurately map a portion of a glacier; to set several series of stakes, and to help us locate other measurable features of these glaciers.

Though basically the glaciers seem

to remain unchanged we can discover great variation in surface features from year to year. In 1931 the Lyell and Maclure glaciers were full of crevasses and the bergschrunds were well open. Never since have we found crevasses of any size and only the bergschrund of Maclure has been noticeable. A large ice cave on Maclure last year was missing this year. A marvelous cave was found on Dana this year never open to our knowledge before. One year the surfaces of glaciers are honeycombed by melting and water courses are well developed and the next year the ice will present a smooth surface with practically no melting taking place. These changes are, of course, being studied and photographed.



DANA GLACIER

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## Further Observations on the Mummified Mountain Sheep

By Carl Sharsmith, Ranger-Naturalist

On Oct. 4, 1933, while Park Naturalist Harwell and Assistant Park Naturalist Beatty were climbing over the east lobe of the Lyell Glacier on their third glacier measuring expedition, they made the startling discovery of an intact, mummified Mountain Sheep (*Ovis canadensis sierrae* Grinnell). It was the first complete skeleton of a Sierra Mountain Sheep found in the region, the last living remnants having disappeared from the central Sierra about the seventies or early eighties. Thus it was felt by National Park officials that it was one of the most important discoveries of 1933 in the whole Park System.

The weight of the specimen was 45 pounds. It was shipped to the University at Berkeley for study, and preserved with alcohol and formaldehyde, then subsequently returned to the Yosemite Museum. Here it has sometime been placed on exhibit, and is now in a glass case in the Research Collection. To date it has remained in as perfect a condition as when found.

An examination at the spot of discovery disclosed that only the neck of the animal was broken. The rest of the skeleton was intact, with the exception of the detached front leg and the horn shells, all of which were found nearby. The

flesh, while strangely mummified and shrunken about the skeleton, gave the appearance of what at first glance seemed to be a normal living animal. This, with the posture in which it lay was so realistic that it gave the impression to the discoverers that a live Mountain Sheep stood staring back at them across the ice.

Such an outstanding find prompted speculation as to its history. It was assumed by Assistant Park Naturalist Beatty (Nature Notes, December 1933, page 111) that "the animal was caught in a slide while feeding on the crest of Mt. Lyell and was buried in the Bergschrund." From the Mt. Lyell glacier measurements made by Harwell and Beatty it was estimated that close to 250 years were necessary for the glacier to have carried the sheep to the spot of discovery. To further quote from the same article, Mr. Beatty adds: "this great length of time is borne out by the aged appearance of the horns and the dehydrated flesh. Dr. Erich Wasmund, geologist from Kiel University, Germany, and specialist on decomposition of animals in ice and water, upon examining the specimen stated that the white patches on the back and rump represent "leichenwachs", or corpse wax, an initial stage in the formation of



petroleum." The subsequent appearance of an article by Dr. Wasmund, the translation from the original which accompanies this issue of Nature Notes, gives additional data on the story of the animal.

At the present writing this noteworthy discovery of the mummified Mountain Sheep continues to excite a good deal of interest. An examination of the stomach contents is one of the steps in the usual procedure in the study of an animal by a naturalist. At Mr. Harwell's suggestion such an investigation was carried out by the writer.

An opening was carefully made on the right side of the animal by Ranger-Naturalist Ted Godwin; the first stomach was located in a median position close to the dorsal surface of the body, having shrunk with dehydration from near the ventral surface. The contents were removed as completely as possible and were found to consist of practically pulverized, caked, "dry-as-snuff" vegetable matter, weighing in this dry condition about 6 ounces. When naturally moist in the live animal this weight of food might have been at least three or four times as much. The finely ground condition of the food mass did not appear to be promising material for identifications of the plants of which it was composed. Nevertheless a systematic and thorough search through the mass disclosed ten species of plants, most of which

could be recognized with no doubt as to their identity. These plants were:

1. *Carex breweri*
2. *Carex phaeocephala*
3. *Carex exserta*
4. *Lewisia pygmaea*
5. *Silene watsonii*
6. *Ranunculus eschscholzii*
7. *Delphinium pauciflorum*
8. *Oreocarya confertifolia*
9. *Penstemon menziesii* var. *da-vidsonii*
10. *Antennaria dioica* or *alpina*

From the totality of the stomach contents and the identifiable species contained therein, the following facts were deduced:

1. The animal did not die of starvation. This is the first and most obvious fact. Probably also it did not die by degrees after its injury, such a condition necessarily using up food, but that it was instantly killed by the fall.

2. It was killed during the late summer part of the year. This is evident by the condition of the fruiting parts of the plant material examined. The perigynia of the *Carices* (sheath around seed peculiar to these plants) and their achenes, the partially intact and contained seeds of *Silene watsonii*, and the single nutlet of *Oreocarya*, were completely matured. This condition of these plant parts is seen only in the latter part of August or early September.

Since the Mountain Sheep ob-

tained its food at this time of year, the bergschrund was open. It is practically completely closed the rest of the year. It suggests that the animal probably fell into the open bergschrund from the head wall of the glacier (north face of the mountain), and was thus entombed in the ice. Its origin from the north face was deduced from the location of the carcass when found, since the flow of the ice would have been from this source in this particular portion of the glacier. This point of origin of the carcass was described by Beatty in the Nature Note article already referred to above. That it was entombed and not carried on the surface of the ice is further evidenced by the formation of "leichenwachs" from the fat of the animal, which requires for its creation certain constant moisture and temperature conditions, as pointed out again by Beatty, and by Wasmund in this issue of Nature Notes. Such conditions are possible only with burial within the ice.

3. The animal had traveled over a considerable distance and from a lower altitude during its feeding. The range of the plant species in the list is from *Delphinium* and *Oreocarya*, found at elevations usually below 10,500 feet, to *Carex phaeocephala* and *Silene watsonii*, plants which only begin to appear when 11,500 feet is reached. The *Oreocarya* species, which by a process

of elimination can only be *Oreocarya confertifolia*, is a Canadian to possibly Hudsonian Zone Borage of Great Basin origin. It occurs on the east slope of the Sierra, and Mount Lyell is several miles west of the eastern crest. This leads logically to the next conclusion:

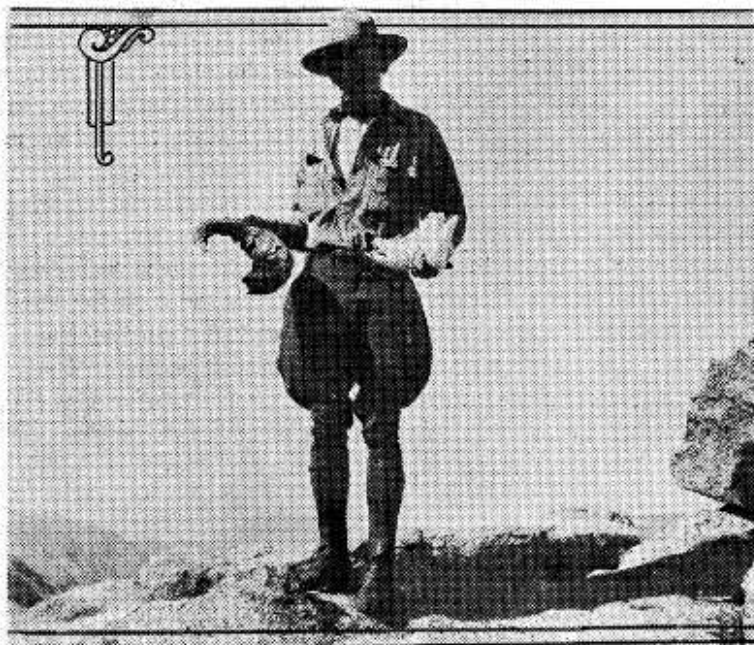
4. Its last journey had been from the east side of the Range, or near it. This is shown by the inclusion of *Oreocarya confertifolia* already referred to. Also two fragments of metamorphic rock which were found in the food mass. Soil particles always adhere to the roots of the heavily-rooted perennials so characteristic of the Boreal Zone. Examination of these makes it possible to determine immediately whether the plant in question was obtained from soil of metamorphic or granitic origin. Most of the metamorphic soils supporting vegetation in the Mount Lyell region are to the east. Thus the assumption can be fairly safely made that the Sheep had come from the territory to the east of the mountain. This assumption is also consistent with the well-known range and travel-movements of the Mountain Sheep, namely centering around the east crest of the Sierra. Furthermore, the animal had completed its feeding before climbing the mountain, since practically none of the plants found in the stomach, occur on the Mount Lyell Crest. This evidence is at disagreement with Mr. Beatty's

belief that the animal had been feeding on the Lyell Crest before it fell to its death. It had evidently gone there to seek shelter.

5. The flora was the same during the life of the Sheep as it is at present. The species identified are precisely those which occur at the present time, as is the assemblage for the region. The relative age of the carcass has been variously estimated as: (1) a minimum of 60 years to a maximum of 250 years, based on the formation of leichen-wachs as according to Wasmund; (2) about 50 to 75 years by the condition of the horn shells, as according to Grinnell; (3) from 200 to

250 years based on the rate of flow of the glacier, namely about seven and one-half feet per year to traverse the distance of 1936 feet, according to the studies of Harwell and Beatty. Even at the maximum estimate (250 years) not sufficient time has elapsed to bring about any difference in the flora of the region.

The conclusions reached by the above study of the stomach contents corroborates in general the views of Beatty and Wasmund as to the sudden death of the animal by a fall, and its burial within the ice-mass by means of the bergschrund which was open to receive it.



Mt. Sheep horn-shells and skulls are still found at high elevations

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## THE YOSEMITE NATURAL HISTORY ASSOCIATION

### ITS PURPOSES

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1. To gather and disseminate information on the wildlife of Yosemite National Park.
2. To foster the activities of the Yosemite Museum (in cooperation with the National Park Service), adding to its collections by the purchase of exhibit materials.
3. To promote the educational program of the Yosemite Naturalist Service.
4. To assist in the publishing of "Yosemite Nature Notes."
5. To study living conditions, past and present, of the Indians of the Yosemite region; to encourage their arts and perpetuate their traditions.
6. To help maintain in the Yosemite Museum a library of historical, scientific, and popular interest.
7. To further scientific investigation along lines of greatest popular interest and to publish, from time to time, bulletins of non-technical nature.
8. To strictly limit the activities of the association to purposes which shall be scientific and educational, in order that the organization shall not be operated for profit.

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We invite anyone interested in Yosemite to join the Yosemite Natural History Association. Yosemite Nature Notes, issued monthly, are sent to all members. Substantial savings are offered members through combination club offers with the American Nature Association and the American Forestry Association.

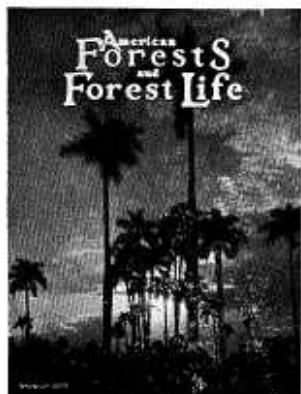
Membership rates and application form appear on the back of this sheet.

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