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Archeology for Layman and Scientist at Mesa Verde

Archeological sites provide in-place exhibits for visitors and research opportunities for scientists.

Robert H. Lister

It is likely that more individuals have had the opportunity of examining first-hand the remains of prehistoric American Indian settlements in Mesa Verde National Park than in any other place in the United States. In 1966, 423,366 visitors spent from a few hours to several days in the park, and during the summer of 1967 alone visitors numbered 322,444. Those who go to Mesa Verde are shown the ruins of habitations and the archeological specimens from these ruins which illustrate 700 years of cultural development by prehistoric sedentary farming Indians known as the Anasazi. Archeologists have borrowed the term Anasazi, "the ancient ones," from the Navaho Indians; these Indians use it in referring to the people who built the villages whose ruins dot their reservation, but the Navaho are not related to the ancient Anasazi. At Mesa Verde competent park rangers interpret the archeological evidence in the ruins, and natural history and archeological museums contain exhibits that show the environment and natural resources of Mesa Verde and also how the Anasazi utilized these in making a living. A permanent staff of 8 rangers, augmented by 33 seasonal rangers during the summer and supported by an administrative force, handle the interpretive programs, protection, and business of the park. My purpose is to review the archeological findings in Mesa Verde National Park, to point out the scope of recent research programs that have emphasized interdisciplinary approaches, and to sketch the present state of knowledge and some of the problems associated with the human prehistory of the area.

Mesa Verde, created as a national park in 1906, consists of about one-half of a tableland or mesa in the southwestern corner of Colorado. The mesa, measuring about 15 by 20 miles (24 by 32 kilometers), rises from 1000 to 2000 feet (305 to 610 meters) above the surrounding country. Its flat top slopes gradually to the south and is cut by a series of rugged canyons that divide the larger mesa into a number of smaller finger-like plateaus. A heavy forest of pinyon and juniper keeps the mesa perpetually green and at some early date, perhaps during the period from 1765 to 1841 when there was much Spanish activity in the area, it was given the name Mesa Verde or "green table." Slightly over 52,000 acres (2100 hectares) of the mesa comprise the park.

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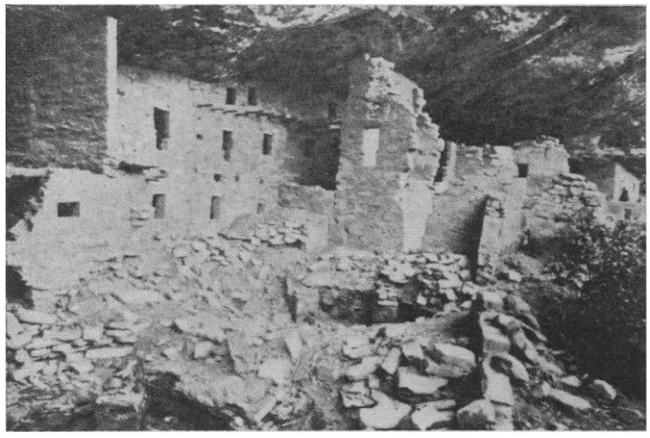
Discovery and Early Archeology

The archeological richness of the area first became known in the 1880's when cattlemen, who used the deep protected canyons of the mesa as winter range, discovered the large cliff dwellings. It soon became evident that there was a ready market for the artifacts that they contained, and for about 20 years the cliff dwellings were ransacked. The Wetherill family of Mancos, Colorado, was particularly active in exploration and excavation of ruins, not only on the Mesa Verde but elsewhere in adjacent parts of the Southwest. Although their activities are generally disparaged as amounting to unscientific collecting, the Wetherills did contribute to Mesa Verde prehistory in their early recognition of chronological differences between the remains they found, through their many fine collections that were obtained by museums rather than by private buyers, through their at least partial documentation of artifacts, and by their cooperation with early scholars who were attracted to the area (*1*).

The first documented archeology in Mesa Verde was accomplished in 1891 by Gustav Nordenskiold of Sweden who, hearing of the Wetherills' discoveries while on a western trip, came to Mancos to see for himself. He was so intrigued by what he saw that he decided to spend the summer in more thorough investigation. In spite of the fact that every cliff dwelling in which he conducted excavations had been searched by the cowboys, he did succeed in obtaining architectural plans and artifacts from 14 of them. His report, although not describing the extent of his excavations in detail, contained good site maps and excellent descriptions and photographs of specimens and houses. When one considers the date of his work, some of his speculations are remarkably apt (*2*).

Two years after Mesa Verde was designated a national park and its archeological remains were placed under perpetual protection, Dr. J. W. Fewkes of the Smithsonian Institution, Bureau



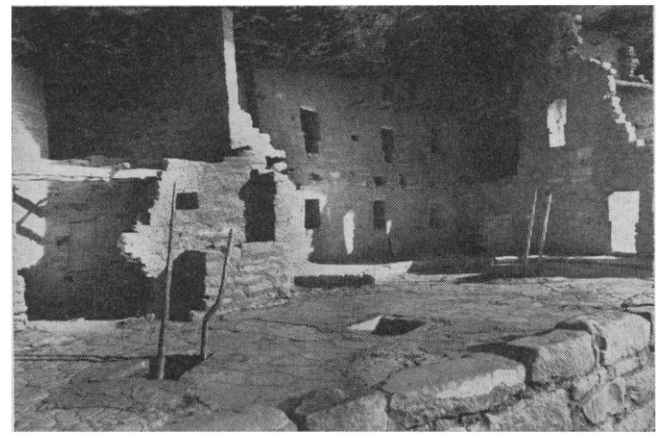


Fig. 1 (left). Spruce Tree House before clearing. Fig. 2 (right). Spruce Tree House after clearing and stabilization by Fewkes and others. The two kivas in the foreground have been reroofed.

of American Ethnology, began a program of archeological research that he continued until 1922. A number of the cliff dwellings, such as Cliff Palace and Spruce Tree House (Figs. 1 and 2), and some of the larger mesa-top ruins, including Far View House (Fig. 3), were cleared and preserved. Fewkes's interest in architecture and its symbolic interpretation regrettably took the place of scientific methods in most of his work (*3*).

Little archeological research was accomplished in Mesa Verde during the 1920's and 1930's, although Dr. A. E. Douglass collected tree-ring specimens from ruins in the park that were significant in his development of an accurate timepiece for the Southwestern archeologist and that led to the eventual dating of the ruins from which the samples were taken. In 1939 modern scientific archeology was initiated in Mesa Verde and attention was focused not on the spectacular cliff dwellings and large sites on the mesa tops but on the simple, subterranean pit houses and small villages of poles, mud, and rough stone masonry that are manifestations of the way of life prior to the building of the multiroomed, multistoried structures.

Mesa Verde Prehistory

By 1950 sufficient archeological research had been completed, when it was viewed in light of the findings of extensive archeological programs elsewhere in the San Juan River drainage of the Southwest, to permit the setting forth of an outline of the sequence of events and of the cultural achievements of Indians of Mesa Verde (*4*). The story of the Anasazi who occupied Mesa Verde begins in the late A.D. 500's and continues to almost A.D. 1300. Neither the earliest nor the latest aspects of Anasazi culture are known in the park, for the beginnings of this culture have been traced in nearby areas to the first part of the Christian era, and, after leaving Mesa Verde, the Anasazi people continued to occupy villages to the south in New Mexico and Arizona until the arrival of the Spaniards in the 16th century. The Spaniards called these people Pueblos because they lived in towns. Without doubt some of the modern Pueblo Indians are the direct descendants of the ancient people of Mesa Verde.

The first Indians known to have occupied Mesa Verde were farmers who cultivated corn, beans, and squash; they had also domesticated the dog and possibly the turkey. Deer, rodents, and other animals were hunted, and edible and otherwise useful wild plants were gathered. Dwellings were shallow pit houses, circular to roughly rectangular, with an above ground, flat-roofed superstructure of poles, brush, and mud (Fig. 4). Most houses were grouped in small settlements on the tops of mesas,

Fig. 3 (left). J. W. Fewkes excavating at Far View House in 1916. The mule team is being used to remove loads of heavy stones from the excavated areas. Fig. 4 (right). Remains of a shallow, slab-lined pit house dating from the first quarter of the 7th century. A rimmed fire pit is located on the floor. A truncated conical superstructure of poles, brush, and mud was supported by four posts embedded in the floor.

but some have been found cut into the floors of caves. Baskets and bags were woven, but their importance was declining because of the advent of pottery. The bow and arrow was prevalent, and stone axes, mauls, and cutting tools were employed. Food plants were cultivated with wooden and stone tools; implements of coarse stone were used for grinding corn, as well as plant remains. In this process a mano, or hand stone, was propelled back and forth on a rectangular slab, the metate, upon which the items to be pulverized were placed. Deer and turkey bones were used for awls in sewing and basket weaving, and for scrapers in the processing of animal skins. Tips of deer antler were employed to chip stone into arrowpoints, knives, and other sharp-edged tools. Pubic aprons, breech cloths, headbands, belts, and sandals were woven of the fiber of wild plants, such as yucca. Blankets, which undoubtedly were worn as outer garments during cold or inclement weather, were made of animal hides or were woven of strips of rabbit fur or strings to which turkey feathers had been attached. Ornaments of stone, bone, seeds, and shell were worn.

There are abundant remains in the Mesa Verde that are representative of this initial period of occupation. At least 15 of the early pit houses have been excavated; numerous others have been noted from surface indications, such as shallow depressions and scatterings of broken pieces of pottery and other artifacts characteristic of the times.

The basic pattern of culture of the Mesa Verde Anasazi did not change throughout their long occupation of the area. They remained village dwellers who subsisted largely on the crops they raised but who depended to a considerable degree on hunting and gathering of wild animals and plants. However, elements of their culture were not static. There were changes in style of habitations and settlement pattern; specialized ceremonial structures, known as kivas, were introduced; pottery was improved; some new forms of artifacts, clothing, and ornaments came into existence; and cotton was introduced. All of these changes and innovations are taken into account by archeologists when they set up stages of Anasazi cultural development.

Variations in the form of houses, the style of kivas, and the location of villages are most apparent. The shallow pit house described above became deeper until the entire feature was subterranean, and hence did not require aboveground walls. The first substantial surface houses appeared about A.D. 700. They were rectangular flat-topped units whose walls and roofs were built of poles covered with thick layers of mud. Usually they were grouped into villages of contiguous rooms arranged in crescentic rows. In front of these units there were, normally, several deep pit houses, sometimes circular but more often rectangular. It has been suggested that the combination of houses may reflect seasonal use, the pits serving as winter shelters and the surface rooms as summer dwellings. The pits also show some details to indicate that they were used for certain religious practices as well as for habitations, and some of the aboveground rooms may have been used solely for the storage of surplus foodstuffs.

Small surface pueblos of rough masonry made their appearance next. These evolved into large L- or U-shaped units of well-constructed masonry containing many rooms and sometimes standing several stories high. In these later villages, the old pit house, with certain additions and refinements, was retained as a religious structure or kiva. Each kiva was probably used as the center of ritual observances for a social group, such as a clan or a religious society. Smaller villages contained a single kiva, larger ones had several; they were usually placed in village courtyards. In many of the later villages, circular towers were built adjacent to kivas and sometimes the two were connected by means of an underground tunnel. Towers were probably used for esoteric rites.

Until about A.D. 1050 villages of the varying styles of architecture were situated on the tops of the mesas. Thereafter there was a drift off the mesas as a trend developed toward placing settlements on talus slopes or in canyon bottoms. The last stage of occupation of the Mesa Verde witnessed a rise in the use of caves when large villages, or cliff dwellings as they are commonly called, were built in the protective confines of shallow caves or rock shelters high above the canyon floors. It is the remains of these structures, located in spectacular settings, which have attracted the most attention since their discovery by the cowboys nearly 80 years ago. Between A.D. 1200 and 1300 many cliff dwellings were constructed. They range in size from one room to the 200-room Cliff Palace, the largest of these dwellings, which also has 23 kivas. They show no definite arrangement, for the builders were forced to fit the structures to the available cave space. Masonry in them varied greatly, with crude and superior types side by side. Many rooms are small cubbyholes that are thought to have been for storage. Living rooms, likewise, were tiny by our standards. Because of the protection from the weather afforded by the overhanging rock many rooms were not roofed with poles but were built to the top of the cave, which served as a ceiling, or sometimes were left unroofed. Many of the pueblos in the caves were terraced up to a height of two and three stories and contained towers of equal elevation.

After the kiva became an integral part of Anasazi villages it went through a series of changes just as the habitations did. From a simple unlined pit with a flat roof supported by four posts, it progressed to a stone-lined subsurface structure with a cribbed log roof resting upon six stone columns built against the inside of the kiva wall. There is a bench around the wall, and a fire pit is situated near the center of the chamber. A small hole, known as the sipapu, is cut into the floor. [This is still found in some modern Pueblo Indian kivas and is said to represent the mythical entrance to the underworld from which the people emerged and where many supernaturals still dwell.] A ventilating system, consisting of a horizontal tunnel extending south from the kiva at floor level for a distance where it is joined by a vertical shaft leading to the surface, allowed fresh air to enter the otherwise poorly ventilated pit. Other lesser elements were added to the Anasazi religious unit from time to time and older features underwent changes. Again, it is the sequential development of these characteristics that allow archeologists to place a given kiva in its proper chronological position, especially if it does not contain datable wood or charcoal.

Pottery

Pottery was an important feature of Mesa Verde culture from beginning to end. It is equally important to the archeologist, for it is a sensitive time-marker and an indicator of certain cultural practices and processes. Pottery probably did not originate with the Anasazi, but was introduced from Mexico by way of another group of prehistoric Southwesterners, known as the Mogol-

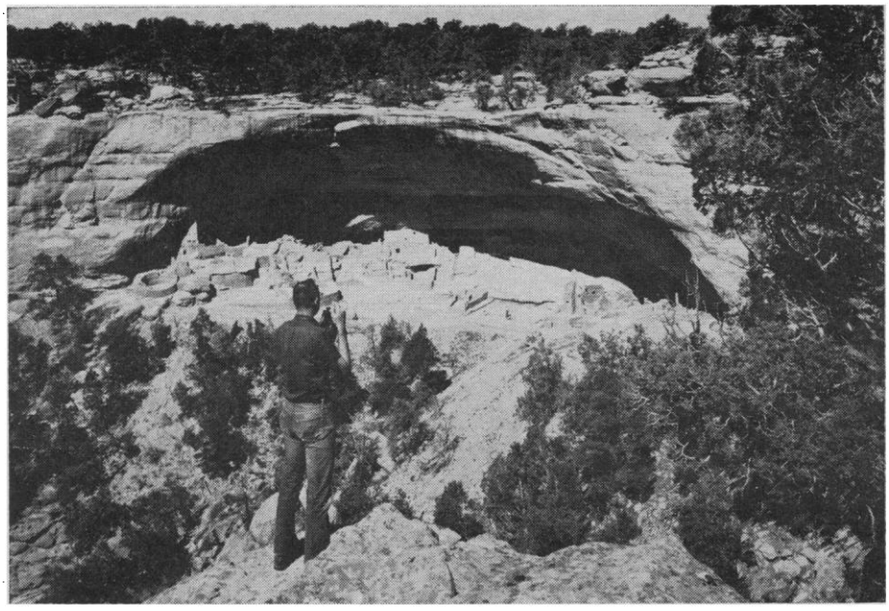


Fig. 5. View of Long House, the second largest cliff dwelling in Mesa Verde National Park. It has been excavated and stabilized as a part of the Wetherill Mesa Project and will be opened to park visitors when a road and other facilities on Wetherill Mesa are constructed.

lon, who resided in southern New Mexico. Two contemporaneous traditions are observable in Mesa Verde ceramics. One features a gray ware that seemingly was employed primarily for cooking and storage. It occurs as bowls and various jar forms for the most part; it developed from smooth-surfaced vessels to forms with banded necks and finally to containers with allover corrugations on their exteriors. The second tradition involves a white pottery decorated with black designs. In its early forms the black paint was made from a mineral containing iron, but after about A.D. 1050 Mesa Verde potters seemed to prefer a carbon pigment obtained from plants. Vessels decorated in black on white were shaped into bowls, jars, mugs, ladles, and various anthropomorphic and zoomorphic forms. Certain shapes and design styles are characteristic of particular periods. These vessels do not appear to have been used for culinary purposes, although some of the larger jars may have served for storage. Most of them were employed as containers from which food was eaten or served. Effigy vessels and pots of unusual shapes may have had ceremonial significance. A few red vessels, used by the Mesa Verde people, probably were not manufactured locally but were obtained by trade with neighboring Anasazi peoples.

The traditions that are apparent in the ceramics of Mesa Verde are quite widespread elsewhere in the northern part of the Southwest. However, despite their broad similarities there are distinctive regional differences in such features as shape, decorative elements, temper, clay, and pigments that help to identify wares from different areas and from particular periods.

Although there were obvious and easily recognized alterations in architectural style, settlement patterns, and pottery wares during the 700-year occupation of Mesa Verde by the Anasazi, there were other less eye-catching but equally important developments and innovations in various kinds of artifacts, clothing, and ornaments. Such items as axes, metates and manos, sandals, baskets, and many other minor culture traits went through stylistic changes.

At any given time in Mesa Verde prehistory a generally consistent complex of culture elements was shared by the residents of the region. The way of life of the earliest Indians in the park has been reviewed, and, as noted above, a fair number of archeological sites illustrative of the period have been excavated. By the early 1950's archeologists had cleared a series of approximately 20 ruins, including a few cliff dwellings about which scientific data is available, which cover the remaining span of the prehistoric occupation of Mesa Verde. These sites range in style and time from deep pit houses of the late A.D. 600's to pole, brush, and mud units typical of about 700 to 900, through the small mesa-top pueblos of the period 900 to 1100, and finally to the larger 12th- and 13th-century complexes on the mesas and in the caves.

Wetherill Mesa Project

During the last 15 years there has been a flourish of archeological activity in Mesa Verde National Park. The recent research has not greatly altered the general picture of the prehistory of the area as previously determined, but it has produced much more data and materials to support or somewhat change former opinions and has brought the interests and methods of numerous other sciences to bear upon archeological problems.

The Wetherill Mesa Archeological Project, conducted between 1958 and 1965, was the largest archeological program carried on in Mesa Verde and ranks among the most extensive ever performed in the United States. It was designed to both achieve park expansion and obtain scientific information. As the park became more and more popular, increasing thousands of visitors came to see its great outdoor museum. Additional excavated archeological sites were required so that more and better interpretive exhibits and programs could be developed for the present-day crowds and those of the future. Wetherill Mesa, one of the westernmost plateaus of the Mesa Verde and named by Nordenskiold for John Wetherill and his brothers, was chosen as scene of the park's new archeological expansion. This was an excellent choice because Wetherill Mesa contains several well-known cliff dwellings including Long House, the second largest within the park (Fig. 5). It also was known to have many other sites believed to represent all stages of the Mesa Verde cultural continuum, and furthermore it was accessible by road from the developed sections of the park (*5*).

The project initially was supported by National Park Service funds that were designated for archeological survey, excavation, stabilization of excavated sites, laboratory analysis of archeological specimens and data, and preparation of reports. Shortly after the program got under way the National Geographic Society agreed to provide additional funds so that the project could undertake research activities that could not be supported by federal funds. This allowed archeologists and other scientists, both project staff members and collaborating specialists, to explore numerous

problems of prehistoric life that are not included in the usual archeological program. Over $1 million, from the combined support of the National Park Service and the National Geographic Society, was expended by the Wetherill Mesa Project (*6*).

During the course of the Wetherill program three cliff dwellings were cleared and eight other ruins were excavated. Together they demonstrate all aspects of the Mesa Verde cultural sequence. Sites, or sections of sites, that have interpretive value and that can be used as exhibits-in-place were stabilized concurrent with excavation so that they will withstand the elements and the wear and tear of park visitors for years to come. Poorly preserved sections of masonry have been rebuilt, shaky foundations have been strengthened, and cracks in ancient walls have been repaired (Fig. 6). Shelters will be built over some of the sites on the mesa top to provide additional protection.

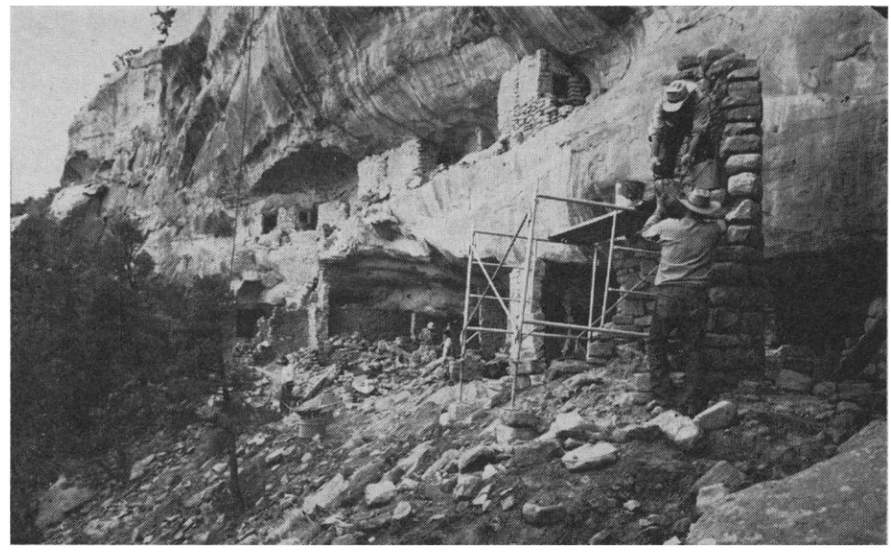


Fig. 6. Stabilization crew at work in a Mesa Verde cliff dwelling. Weak foundations are strengthened, badly preserved walls are rebuilt, and many walls are capped by removing several courses of stones from the tops and edges of walls and resetting them in properly tinted cement.

A staff of up to eight archeologists directed the field excavations and the laboratory aspects of the Wetherill Mesa Project. A thorough survey of the archeological resources of the mesa was one of the first steps taken. The site reconnaissance of an area 10¼ miles long with an average width of a little less than a mile required 13 months. All places that showed some evidence of aboriginal activity, from a pictograph to any kind of habitation, were considered sites. Slightly over 800 were located by the survey (*7*). The heavily wooded mesa top presented the most difficulty to survey crews. Traversing the flat ground and finding a site was no problem, but accurate location of it where visibility frequently was limited to 50 to 100 feet was another matter. A system of location by radio direction finder was devised that involved the use of two low-power, tripod-mounted, portable transmitters placed over known points and a small receiver that was carried to the site to be surveyed. The receiver, after being oriented, was tuned to each transmitter in turn and the two azimuths were plotted. This system made it possible to locate sites with reasonable accuracy and saved many man-months of labor (*8*).

The survey not only provided scientific information about density of population and kinds of sites present on Wetherill Mesa during different periods of occupation, but it also aided in determining which ruins should be excavated to best illustrate the archeological story and how roads, trails, and other facilities for visitors could be developed with as little destruction as possible of the archeological and natural values that the park was established to protect. Aside from the stabilization aspect, excavations on Wetherill Mesa were not unlike other contemporary archeological research. Many of the problems of logistics, in fact, were created by the necessity of transporting sand, cement, water, scaffolding, and other items of equipment necessary for repairing and preserving the ruins, especially the cliff dwellings. All field work was completed in 1963; laboratory and desk activities continued until 1965.

Interdisciplinary Programs

The National Geographic Society program, designed to allow the Wetherill Mesa Project to transcend the scope of "normal" archeological investigations, led to the formulation of a number of specialized archeological studies and interdisciplinary programs that have yielded, or offer promise of producing, significant results. These ancillary investigations were quite diversified and, because the project was large and had adequate support, were not limited to tried and true lines of research but included a reasonable amount of probing and experimentation.

Approximately 30 separate fields of study, over and above basic archeological survey, excavation, and laboratory analysis, were brought to bear on problems and questions concerning the past and present environments of Mesa Verde National Park. Studies were grouped into two major sections: (i) anthropological and medical sciences and (ii) the earth, life, and meteorological sciences. The first grouping produced data and interpretations that will add to our knowledge of the prehistoric way of life at Mesa Verde and to the circumstances that contributed to its decline as an Anasazi center, the reasons for its abandonment, and something of the fate of the emigrants and their descendants. The second grouping was designed to fill out our knowledge of the environments of the past and present, and to provide dates for the cultural materials.

The variety of projects may be illustrated by briefly describing some of them. Ethnologists who have specialized in Pueblo Indians were asked to examine archeological data and specimens and to comment on any aspect of the nonmaterial culture that they might detect therein, such as kinship groupings or ceremonial practices. Glottochronology, an anthropologically influenced approach to linguistic time depth, was employed in studying the language of the Ute Indians to determine whether they have been in the area long enough to have possibly been a factor in the abandonment of Mesa Verde.

Studies of the water supply, involving an investigation of the best-preserved ditches, reservoirs, check dams, and terraces, have been made. A study of archeological collections, which were taken from Mesa Verde during the last

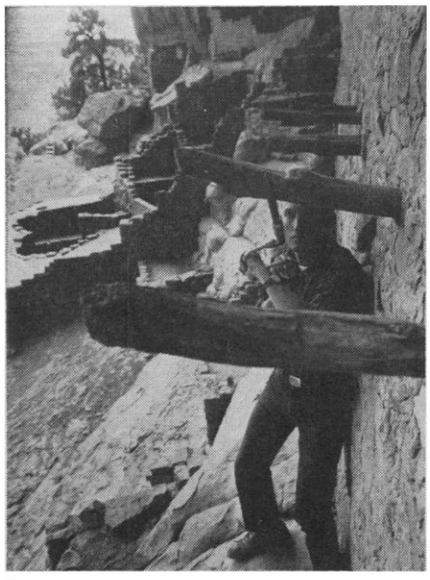


Fig. 7. A construction beam in Long House is cored for tree-ring dating with the use of a special hollow bit in an ordinary brace.

quarter of the 19th century and which have found their way into museums across the country, has rounded out our understanding of the technology and material culture of the late cliff-dwelling population. Augmenting the usual physical anthropological investigations of metric recordings and observations upon the human skeletal remains from archeological excavations were a series of studies concerned with osteopathology, orthodontics, and parasitological investigations and studies of diet based upon examination of human fecal samples taken from the cliff dwellings.

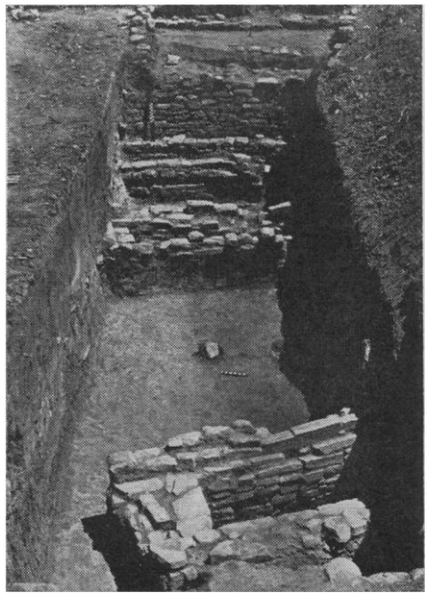
Palynological work has involved the collection and analysis of hundreds of pollen samples from mesa tops, deposits in the ruins, and behind check dams and terraces. The results are encouraging and will allow for generalizations to be made about the flora and floristic changes during the occupation and after abandonment.

The Wetherill Mesa Project had one of the most intensive dendrochronological programs in the history of Southwestern archeology. More than 500 individual dates have been obtained from over 1900 specimens of wood and charcoal collected during the excavation of 11 ruins (Fig. 7) (*9*). This research has not only provided dates for the sites but these dates have also permitted the extension of our understanding of and speculations about the lives of the people who constructed the dwellings. Sequences of construction within and between ruins have been determined; the datings of alterations in artifacts, styles, and practices have been established in some cases; and it has been shown that tree-ring data may be used for climatic reconstruction. Studies of tree growth and dendroclimatology and environmental measurements were conducted to establish a basis for the use of tree rings and other regional environmental data in comparing our present-day climate with that of the past.

Studies of the soil were directed toward providing a moderately detailed soil map of Wetherill Mesa and an understanding of local soils and their development. Aboriginal patterns of settlement and farming lands will be correlated with soil conditions. Zoologists and botanists have identified animals and plants that were used by the Indians as foodstuffs or as artifact materials and have made detailed studies of modern animal and plant ecology. The latter studies produced modern base lines against which to project the information on ancient faunal and floral populations, and thus to make available some data on past environment through a knowledge of the animals and plants living then.

So far one major monograph (*10*), which reports results of the survey, and over 40 short papers, which deal mainly with ancillary projects, have been published (*11*). By the end of 1968 at least six more monographs are scheduled to be issued by the National Park Service.

The University of Colorado conducted an archeological program in Mesa Verde prior to the Wetherill Mesa Project and, since the conclusion of the project, has expanded its activities by establishing a research center that utilizes some of the facilities constructed for the Wetherill project. The university program has both research and training



Figs. 8 and 9. A Mesa Verde great kiva, measuring 70 feet in diameter, during excavation. The structure was excavated a section at a time. Features exposed in each section were recorded and then backfilled by dirt from the adjacent section. Fig. 8 (left) shows a cleared section in which portions of two floor vaults are exposed. Fig. 9 (right) shows the southern portion of the structure, additional parts of the two vaults, a firebox, and two of the four masonry-lined holes that originally contained large roof-supporting posts.

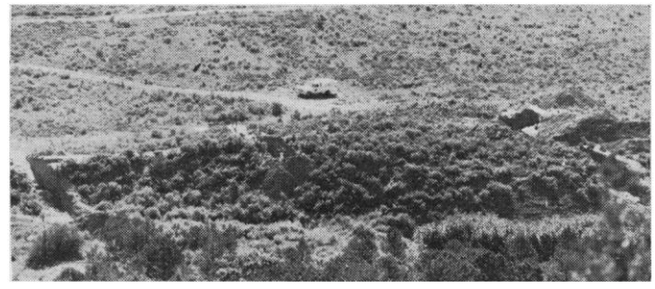


Fig. 10 (left). University of Colorado excavators use a front-end loader to cut trenches through a prehistoric reservoir. Profiles of the trench walls revealed layers of fine gravel, sand, and clay representing water-laid deposits in the reservoir proper, and at the upper end of the structure the intake ditch was found. Fig. 11 (right). Sagebrush-covered hill marks site of 11th-century reservoir whose deposits were exposed for analysis by trenching with mechanical equipment.

aspects, since its investigations are directed by staff archeologists who employ graduate and undergraduate students for most positions from field foremen to shovelers. Six villages and a variety of isolated features have been excavated by Colorado archeologists (*12*). They also have accomplished a number of salvage projects associated with new developments for the park, such as roads, trails, pipelines, and campgrounds. One research program involved the clearing of four neighboring ruins that revealed a 200-year span of occupation and provided information about density of settlements and utilization of lands and of systems for water control. Other excavations have shown that the Mesa Verde Indians, like their neighbors, constructed great kivas—large communal ceremonial chambers that must have been the scene of greater and perhaps more important rites than were performed in ordinary kivas (Figs. 8 and 9). During the summer of 1967, a series of long trenches dug with mechanical equipment through a large mound in a valley bottom demonstrated that it was the remains of a prehistoric reservoir that had provided water for a number of villages in the vicinity (Figs. 10 and 11). Archeological inventories have been made of certain government-controlled lands adjacent to Mesa Verde, and in October 1967, repair and stabilization of Lowry Pueblo was completed and it was dedicated as a national historic landmark.

Abandonment of Mesa Verde

A problem that has been foremost in the minds of many archeologists and others from the time Mesa Verde was discovered has to do with its abandonment, which we now know took place in the late A.D. 1200's. Recent work has thrown some light, but not complete clarification, on this matter. Formerly, the shifts of population by Mesa Verde peoples from the mesa tops to the caves, and even the eventual abandonment of the area, was attributed by some to the pressure of nomadic invaders who were generally presumed to be the Navaho. It is now debatable whether the Navaho had arrived in the Southwest before the Anasazi left Mesa Verde. If they were not the enemy people, could the Paiute or Ute have been the culprits? At present, opinions on this question vary (*13*). The effectiveness of relatively poorly equipped nomads against well organized Anasazi pueblos also is being questioned. Might not some of the defensive mechanisms exhibited by the Anasazi have been directed toward some of their Anasazi neighbors as a consequence of internal problems? The Great Drought of A.D. 1276 to 1299, or 1273 to 1285 according to the latest studies, has been considered by other scholars to have been the chief cause for the desertion of the Mesa Verde by agricultural Indians since the abandonment coincides with the time of the drought. Recent research on tree rings shows that the so-called Great Drought at Mesa Verde was surpassed in intensity by six other droughts during the period A.D. 500 to 1300, which suggests that the drought alone did not bring about the movement away from the Mesa Verde (*14*). Research of the past few years has made it possible to comprehend the density of population on the Mesa Verde and to recognize the problems that evolved from that situation. To make a living under increasingly difficult circumstances the people tilled practically all arable lands; created additional farming lands by terracing; and gathered, stored, and distributed water for both irrigation and household uses.

Today therefore, in attempting to account for the ultimate abandonment of Mesa Verde, not one but several factors must be taken into account, including possible harassment by an enemy, deficient rainfall and water supply, density of population, scarcity of farm lands, decrease of available resources, and quarrels with one another over such matters as favorable lands and sources of water.

The Future of Mesa Verde

It might sound as though there were no future for archeological research in Mesa Verde because all of the significant sites have been excavated, or because the story of the people who lived there is completely understood. Neither is correct.

There are a great many archeological sites in Mesa Verde. Recall that the survey of Wetherill Mesa located slightly over 800, and Chapin Mesa, a somewhat larger area, has almost 1000 sites. Add to these about 130 more cliff dwellings and randomly located ruins on mesas and in canyons and we have a total of about 1930 recorded sites in the park. The great majority of these are on Wetherill and Chapin mesas, the only ones that have been systematically searched for ruins. If the additional ten or more mesas and intervening areas in the park were carefully examined the total would be much higher.

There are reports, or reports are forthcoming, on only about 56 excavated or cleared Mesa Verde sites; 20 of these are cliff dwellings or mesa-top pueblos investigated by Nordenskiold or Fewkes. Nordenskiold's reports are not detailed, although they are useful to some degree, but Fewkes's are almost completely inadequate. Therefore, our present knowledge of the prehistory of Mesa Verde National Park comes mainly from about 36 sites in the park and, of course, from data obtained from excavations in surrounding areas. Many

unexcavated ruins remain in the park. This is fortunate, for they constitute a unique archeological reserve. Even though a great many sites of Mesa Verde culture exist outside the park, not many of them have escaped complete or partial destruction from agricultural or range expansion or from the activities of pothunters. However, the ruins in the park have been protected for over 60 years and will continue to be hereafter. In the future, sites will be excavated that promise to contribute to a particular scientific or interpretive problem or when new techniques of excavation or analysis are devised that will allow a fuller recovery of useful data from the investigations.

There still are problems to be solved about the peoples of Mesa Verde and their culture. Their relationships to other prehistoric developments elsewhere in the Southwest, and even in Mesoamerica, need to be considered; better knowledge of their adjustment to and control of their environment will be investigated; and, archeologists hope, a fuller understanding of the social, economic, and religious aspects of their lives will be obtained. As new finds are made by archeologists and their coworkers they will be reported to fellow scientists and incorporated into the interpretive programs and exhibits at Mesa Verde by the National Park Service for the benefit of park visitors.

References and Notes

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15. Figures 1 to 7, courtesy of the National Park Service.

Cortical Patterns in Cellular Morphogenesis

Differences in cortical patterns in ciliates may be hereditary, but independent of genic differences.

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An essential advance in our understanding of cellular differentiation came with the recognition that the activities of genes are capable of systematic and programmed regulation. The earlier view was that genic activities, like genic structures, are largely and necessarily immune from extranuclear interference. The experimental basis for this interpretation was tenuous, but its influence was pervasive. Cellular differentiation was conceived in terms of interaction of "gene products," occurring in the cytoplasm and conditioned by a variety of intra- and extracellular environmental circumstances. Because the gene products themselves were many and ill defined, because many of the significant environmental variables could only be guessed, and because the essential variability in the kinds and numbers of gene products was not grasped, interpretations of developmental events tended to be formalistic, untestable, and essentially sterile.

Perhaps the transition era began in the 1940's with a recognition that the usual gene product is a protein, coupled with an appreciation that the protein compositions (and particularly the enzymic capabilities) of cells change in the course of development. But the reality of functional nuclear modification was established more directly through studies in the 1950's on nuclear transplantation in amphibia, through cytological and cytochemical observations on polytene chromosomes in insects, and most convincingly by an explication of genetic regulatory elements in bacteria. Not only is the fact of nuclear regulation established beyond any reasonable doubt and in a variety of biological systems, but basic mechanisms responsible for the regulation of genic functions have been identified, and experimental procedures for discriminating among them have been developed. We now speak confidently of transcriptional control and translational control, depending upon whether regulation occurs at the level of synthesis of messenger RNA or during the fabrication of polypeptide chains. We do not yet understand sufficiently well the mechanisms whereby the qualities and quantities of gene products are controlled, but the fact of such control is compellingly established and has become the cornerstone of any synthetic edifice in developmental biology.

The question I discuss here, however, is not the validity of nuclear modification as a factor in cellular differentiation, but its sufficiency. Genic regulation is a beautiful truth, but it is not all we know or all we need to know. The attempt to interpret the interactions of gene products was sterile a quarter century ago, and the time may not yet be ripe for a fruitful analysis. But the problem itself is not obsolete. Eventually cell biologists must rationalize the interactions of gene products which lead to the integrated structural and functional state.

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