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The Petrified Forest National Park and the New Mexico Museum of Natural History: A Case Study in Paleontological Research

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Introduction

"Although the subject matter is dead, the science of paleontology is not" (Kennedy 1984); and though long moribund in the National Park Service, the study, preservation, and interpretation of fossils have gained wide acceptance in recent years, to the extent that paleontology is currently experiencing a resurrection in the NPS.

As Kennedy and others have pointed out, the study of fossils is more vigorous than ever in the past, and the number of paleontologists engaged in serious, academic research grows annually. Public interest in fossils has become so intense in recent years that one can expect to find articles on dinosaurs, extinction, early man, and a myriad of other subjects in the popular press every week. In New Mexico, for example, public sentiment in favor of preservation of threatened fossils was the most persistent argument advanced in the early 1980's to support the notion that the state should build a state museum of natural history; the idea bore fruit on January 9, 1986 with the formal opening of the New Mexico Museum of Natural History.

During the same period, from 1980 to 1986, scientific interest in fossils of the Petrified Forest National Park intensified beyond all expectation, largely because of the realization that fossil vertebrates dating from the Triassic Period, 220 million years ago, are abundant, diverse and technically important to science. Paleontological research programs at the park have liberally expanded to include fossil animals, a new dimension added to the historical focus on petrified logs. The new interpretive theme in paleontology at the park now revolves around "The Dawn of the Age of Dinosaurs", an enlightened expansion in scope and goals that presents the park and its resources in a balanced perspective.

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One key to this success has been the establishment of research programs that have brought professional paleontologists from other institutions into the park. The benefits from this approach have been reciprocal, simultaneously enhancing researcher's studies and park interpretation. Our experiences should prove instructive for NPS managers who wish to expand paleontology in their parks.

CENTRAL THESIS

The central thesis in the following pages is that paleontological research in the Petrified Forest National Park is beneficial to science, to the public, and to the National Park Service. The principal corollary is that paleontological research can be as productive in other National Parks as in the Petrified Forest.

Paleontological Research History of Petrified Forest

Petrified Forest National Park has long been the scene of paleontological, geological and archeological research. Modern research dates from when John Muir walked into these ancient geologic formations around the turn of the century, and continues today.

In the winter of 1905-1906, John Muir came to the region so his daughter could recuperate from tuberculosis. At what we now call Blue Mesa and Black Forest, he discovered deposits of fossil bones he thought to be the remains of Pleistocene (1.8 million to about 10,000 years ago) mammals. (The bones were later identified as those of Triassic reptiles). Muir took specimens with him and eventually deposited them at the University of California, Berkeley where they were later examined by Miss Annie Alexander, who was the heir to a great sugar fortune, a graduate of the University of California at Berkeley, and an avid amateur paleontologist.

In 1921, Miss Alexander and her companion-secretary, Miss Louise Kellogg, came to the area and began "prospecting" for fossils. They soon found phytosaur fossils around the Teepees section of the park. Later that summer, Miss Alexander persuaded Dr. Charles L. Camp to come to the area and inspect her finds. Camp, having just received his doctorate at Columbia University, and on his way to work at the University of California Berkeley, spent his next ten summers collecting in the rich vertebrate fossil grounds in and around Petrified Forest National Park. Camp's monograph on phytosaurs is still the definitive work on that group of prehistoric reptiles.

During the 1930s and 1940s, park naturalists continued the work. One of the first was Myrl V. Walker, a many faceted scientist with interests in geology, paleontology and paleobotany. After Walker's Ph.D work was interrupted by the depression, he decided on a career with the National Park Service. His Park Service duties revolved about the Rainbow Forest Museum, and his scientific work was carried out mostly on his days off. He specialized in fossil plants, and worked with Dr. Lyman Daugherty of San Jose State University and others to describe the plant fossils of the area.

In the late 1940s, Dr. Edwin H. Colbert, then Curator of Paleontology at the American Museum of Natural History, came to the park and began work on the vertebrate fossils. This work was interrupted in 1948 when Dr. Colbert discovered the now famous Coelophysis Quarry at Ghost Ranch, New Mexico. In fact, as Dr. Colbert remembers, his party was enroute to Petrified Forest for a summer's field work when the discovery was made. Dr. Colbert never returned to the park for extensive research, though in the early 1950s, he conducted an erosion study in the Teepees area and discovered that the rate of erosion is about one-quarter inch per year. Dr. Colbert and his wife, Margaret, are still involved with the park. Dr. Colbert advises the park on scientific matters while Margaret, a fine natural history artist, did the Triassic mural at Rainbow Forest and is working on designs for the Petrified Forest Museum Association. (Established in 1941 by supporters of the park, the Petrified Forest Museum Association sells interpretive literature at the

park's visitor centers. Profits from these sales are donated back to the park to aid interpretation and scientific research)

Dr. Sidney R. Ash, a paleobotanist at Weber College in Utah, began his work in the park in the mid-1960s. Dr. Ash concentrates mainly on plant mega-fossils and has authored many articles and technical papers on the park's ancient flora and geology. In 1986, his major revision of Petrified Forest, The Story Behind the Scenery was published.

Paleontology in the park got a much needed boost in 1981 when a group of paleontologists from the University of California at Berkeley arrived. They were showing a new professor the major fossil areas of the southwest. Robert A. Long, a member of the group, and a protege of Dr. Camp, had brought with him some of Camp's old photos of fossil sites and Long was able to use these sixty year old photographs to relocate several of Camp's old sites and quarries. So exciting was the prospect of renewing research at Petrified Forest, U. C. Berkeley funded a field expedition in 1982. Discoveries that year more than tripled the park's paleo-fauna and resulted in the discovery of several "new" creatures.

In 1983, with funding from the Field Museum of Chicago, U. C. Berkeley and the Petrified Forest Museum Association, another field research season was led by Dr. John Bolt of Chicago. The group hoped to open a quarry in the Painted Desert west of Lacey point but was disappointed when the expected bone layer did not materialize. Instead the group turned its attention to prospecting different areas of the park. The highlight of the year turned out to be the discovery of an animal named Paratypothorax. Known only from armor plates discovered in Germany in the 1880s, the Petrified Forest animal had both armor, ribs and vertebrae. The specimen was removed in a 1200 pound block and is now being studied at Field Museum in Chicago.

1983 marked the beginning of a project by Dr. Mary Krause of the University of Colorado, Dr. Larry Middleton of Northern Arizona University and Dr. Tom Bown of USGS, to study the sedimentology and petrology of the Chinle formation at Petrified Forest. The results of this study will furnish, among other things, new information on the paleoclimate and paleogeography of the area. In 1986, Dr. Hilde Schwartz of Dixon, New Mexico, began micro-stratigraphic studies of Petrified Forest. Her research will compare the micro-stratigraphy of the park with that of Ghost Ranch, New Mexico in an effort to determine the relative age of the two areas.

The 1984 field season was funded by the Petrified Forest Museum Association. Led by Rob Long, and consisting of scientists and graduate students from U. C. Berkely, University of Colorado, Harvard and Texas Tech, heretofore uninvestigated areas of the park were explored for fossils. The same year, also with funding from the Petrified Forest Museum Association, Dr. Sidney Ash spent the summer working on plant fossils. Dr. Ash and his workers have not only found plant fossils but discovered the impression of a two hundred million year old cockroach wing (1983) as well as the impression of an equally ancient crayfish (1984).

One day near the end of the 1984 season, Long's group hiked into the Painted

Desert off Chinde Point to look at some unusual petrified wood. During that trip, Brian Small, then a graduate student at Texas Tech University, found the ankle bone of a dinosaur. Further search turned up more bones weathering out of the rocks. The season was almost over so the bones were covered for the winter with plans to excavate them in the spring. In early June of 1985, supported by the National Park Service and U. C. Berkeley, and amid much fanfare, the bones were removed by helicopter to U. C. Berkeley for preparation and study.

Research in the park continues. Again, largely funded by Petrified Forest Museum Association, there are studies in micro-stratigraphy, vertebrate paleontology, and - a special treat for the public - the preparation in public view of a large crocodile-like phytosaur.

Since 1981, research in the park has dramatically changed the focus of Petrified Forest National Park. From a one-dimensional emphasis on petrified wood, the research has revealed a six million year span where the flora and fauna are in context. Working with the scientists, the National Park Service is presenting that 225 million year old paleo-ecosystem to the public. These efforts are supported by the Petrified Forest Museum Association, funds from the park's donation boxes, and the National Park Service. To give the research focus and scientific direction, Dr. Edwin H. Colbert of the Museum of Northern Arizona, Dr. Sidney R. Ash of Weber College, Dr. Larry Middleton of Northern Arizona University, Dr. David Gillette of the New Mexico Museum of Natural History and Robert A. Long of U. C. Berkeley and Petrified Forest, and archeologists Anne T. Jones and George Teague of the National Park Service's Western Archeological and conservation Center in Tucson, serve on the park's Scientific Advisory Panel.

Petrified Forest National Park contains some of the most important geological exposures of Triassic deposits in the world. Fossils found in these rocks will give science a new and changing perspective of life on earth 225 million years ago. The goal and challenge to the National Park Service, supported by the Petrified Forest Museum Association and many interested scientists and institutions, is to take the technical scientific information and present it to the visiting public in understandable terms. Visitors driving into Petrified Forest each summer, following where John Muir trudged in more than eighty years ago, enter an unimaginably ancient world exposed here better than anywhere else in the world.

Problems and Solutions

Problem 1: Poorly Defined Research Goals

Individual researchers inevitably develop research goals according to their own interests and needs. These goals are not necessarily complementary to park goals and are often contradictory to park needs and policies. Research activities in the Petrified Forest National Park prior to the 1980's, and

still to some extent today, have not been organized to benefit the park or to meet rigorous scientific standards although in every case the standards could have been defined and maintained.

Excavations that have removed fossils from the park have frequently, especially prior to the 1980's, also removed the resource without follow-up benefit to the park. Similarly, permits to conduct excavation or reconnaissance activities have not been submitted in the context of overall research objectives.

Solution: Because the National Park Service supports all research conducted in the national parks directly (through logistic support, use of equipment and facilities, advice of staff and in some cases, financially), or indirectly (through coordination of support from museum associations, facilitating communication and cooperation with other researchers), Petrified Forest National Park has adopted a policy that all research activity conducted within its boundaries must be subjected to the standards of excellence demanded by review panels that advise the National Science Foundation on grant proposals. In that organization, federal support for research is awarded through the time-honored system of peer review which is communicated to administrators who make final decisions that transcend simple merit considerations.

In 1986 Petrified Forest National Park ~~appointed~~ began to work closely with a group of scientists a Science Advisory Board, ~~consisting of~~ These researchers active researchers, ~~and certain park officials, who~~ advise the park and review research proposals to ensure the highest standards of scientific excellence.

The implicit role of the ~~Science Advisory Board~~ scientists is to facilitate fair and impartial peer review of proposals, progress reports, and post-research evaluation. The researcher and this panel are best fit to answer that difficult question, "How could this project have been done better?", as a form of constructive self-criticism. ~~The Science Advisory Board members~~ This group of scientists already have been asked to advise the park administration as arbiters over issues of territoriality, manuscript evaluation and reviews of research proposals.

This ~~panel~~ group evaluates stated and implied goals contained in research proposals, especially ones related to field work and excavation. Trophy hunting, high-grading and directionless field work will be discouraged in the park because these activities can be done elsewhere. Systematic and methodical research will be encouraged, on the other hand, because these activities lead to overall advance in paleontology and overall enhancement of understanding of park resources. As in NSF-funded research, if the goals are not clearly defined, reviewers will conclude that the research plan needs revision or should be rejected.

An important difference from NSF support is the premise that all new knowledge is good and useful without addressing the demands of timeliness or theoretical importance. In the Petrified Forest, we have an exceptional working laboratory in the Chinle Formation, where even inventory research is important and taxonomic evaluations pertinent. The need to understand the

resources within the confines of the park boundaries imparts a necessary provincialism that distinguishes park interests from broader and loftier national interests under the stewardship of the NSF. In other words, expansion of the data base is itself an important park objective, whether or not there are immediate benefits to theoretical considerations.

Problem 2: The "Dig 'em and Hold 'em" History

For paleontologists, support for field work is relatively easy to secure. Most of us do not really understand why this is so, but it must have something to do with the "glamour" or "high-profile" of excavation work compared to the lackluster drudgery of laboratory operations. However, the laboratory work (in paleontological realms this is called "preparation") must follow, in the form of extrication of the fossils, repair, restoration, and curation, and these activities are difficult to support. Petrified Forest National Park, like many other public institutions, has repeatedly hosted field studies that have resulted in significant excavations and far too many of these fossils remain unprepared and unstudied years later.

It seems that possession alone is sufficient reward for the trouble taken by an excavation team, whereas in reality this action removes specimens from the available database, withholds for long periods information on the very existence and condition of the fossils and impedes progress in the science. Moreover, the failure to complete preparation and then to study the materials, harms the park by withholding valuable interpretive information and inhibits coordination or research programs. Inevitably, such a course of events is everyone's loss: the scientists, the park's and the public's. The lack of follow-through is a chronic problem for all paleontologists and any museum director will relate: year after year new plaster jackets containing undeniably "valuable" fossils are added to the bulging storerooms, neglected and soon forgotten.

Solution: Researchers at the park are asked to submit a well-defined plan for preparation and study in their proposals. This demand for follow-up is as important as the plan for excavation and must include identification of available facilities, personnel, and institutional support. Many, or most, vertebrate paleontologists do not have sufficient preparator support at their home institution. A good rule-of-thumb ratio is three preparators for every research curator, a ratio achieved at only a few of the largest museums. The problem is a plague that has hampered all research paleontologists but is is not intractable.

One solution is to scale down the scope of an individual's field work; another is to encourage the researcher to bring in cooperating researchers to share in excavations as well as the follow-up. In many cases, joint operations are more fruitful than operations conducted singly, because of the synergistic effect fostered by mutual interests and cooperation.

At Petrified Forest, we found another solution, one that has the extra benefit of improving park interpretation. In early 1985, a nearly complete skeleton of a twenty foot long phytosaur (a giant predatory reptile that resembled today's crocodiles) was discovered by two paleontologists from the

University of Colorado. Excavations alone would be expensive and there was no assurance of prompt preparation. The park decided to take a new approach. With our organization and supervision and assistance of outside volunteers and park volunteer personnel, we excavated the block which eventually weighed about three tons, at a low actual cost. Park personnel and many local volunteers joined in the experience. Some were Park interpreters, others were park officials and all learned first-hand what goes into an excavation of this magnitude. They have carried their experience to the public and to their jobs, an immeasurable benefit.

The hefty investment that would have gone toward the excavation (by the Petrified Forest Museum Association) was available for follow-up. The block was moved to the plaza at the visitor center, outdoors, and with PFMA support, a preparator was hired to remove rock from the bones in view of the public. According to one count, during the summer months of 1986, visitor contacts with the preparator or an interpreter numbered more than 1000 per day and attention spans were frequently fifteen minutes and longer. The result has been prompt, professional preparation, enhanced interpretation for the public, direct involvement by the park interpreters and others, and overall enrichment of the park's public programs. Within a year of its excavation, the phytosaur will be ready for study and soon thereafter, it will be installed as a permanent exhibit.

We expect to generate donations for this preparator program through sales of an interpretive pamphlet on phytosaurs, which might fully recover the actual costs. These donations in turn can be used for similar projects in future years. The researcher benefits through prompt follow-up, the park benefits through continuity and in-house experience and the public benefits through observing first-hand the slow and methodical progress of paleontology.

Problem 3: Slow and Obscure Publication

The ultimate goal for all research in paleontology is publication of results. The purpose of publication is to share with others the advances gained by a particular research program. To delay publication or to avoid publication altogether, is to impede advance in the science. Except by publication the fruits of our labors will not reach other researchers or the general public and will remain hidden forever, eventually ignored and soon forgotten.

Even prompt publication, however, has attendant problems. Generally the publication of research results is slow even by government standards and usually obscure in the sense that journals are technical, specialized and unlikely to find the eyes of NPS personnel (unless the park in question has a staff paleontologist). In all cases, therefore the real problem is communication: no publication, or publication that is slow and obscure; no reports, or poor reports; no follow-up by researchers to deliver reprint copies of research reports to park personnel; no or little involvement by park personnel, and so on.

Solution: The communication problem has been solved at the park by adoption of several policies and practices. First, the administration has taken a

strong posture on communication from the scientists, demanding prompt and detailed accounts of progress for each project.

Second, to insure that particular projects do not become mired by individuals' fortunes and misfortunes, permits to conduct research in the park are issued to institutions, not to individuals. Institutions are held accountable, rather than the individual scientist; for example, department chairpersons, museum chief scientist, etc. (i.e. institution-to institution "peer pressure").

Third, research personnel are required to deposit technical references in a library file, not only papers they have produced, but also papers that are directly pertinent to park projects and related subjects. This requirement makes technical works immediately available to park personnel and visiting scientists alike, insuring at least a modicum of prompt communication.

Fourth, researchers are asked by the Petrified Forest ~~Science Advisory Board~~ science advisors to submit copies of draft manuscripts prepared for submittal to journals as a courtesy copy, stamped "Not for Distribution" and "Not for Publication Reference." Including these manuscripts in the park technical library accelerates the communication between researcher and park personnel by months and even years (the time from acceptance for publication to actually appearing in print is usually nine months and often as long as eighteen months).

Fifth, researchers are asked to deposit copies of their field notes and related documents such as photographs and maps for the park archives. The objective in this request is to insure that future researchers and park personnel have a record of research activity in the park. Because the activities are conducted on public lands, the information a researcher accumulates should belong in the public domain with certain ethical restrictions that promote confidentiality to the researcher as long as work is in progress.

Problem 4: Feedback to the Park

Once field work and excavation are completed, communications between researchers and park personnel often cease for many reasons: (1) changing priorities; (2) prior commitments to other projects; (3) revised perception of the importance of the project upon later reflection; (4) slow preparation of fossils; (5) slow study of the fossils; (6) needs for museum visits for comparative work; (7) budget impacts. All of these problems are legitimate and must be overcome if the studies are to be carried to completion. For all these reasons and many more, park officials who are left uninformed on the progress of research projects are easily frustrated.

Solution: The problem is essentially a matter of communication. Researchers and park personnel alike must establish mutual efforts to communicate their needs as well as their progress on research. Here the real responsibility belongs to the researcher. The key to success in such communication is mutual involvement. Progress in paleontology is painstaking and always deliberate; by the researcher willingly involving the

park personnel, there will be little need to periodically fill the gaps.

Problem 5: Cooperative Feedback to Other Researchers

Again, this is a communication problem, researcher to researcher. The problem relates partly to a strong tradition of territoriality among paleontologists, an archaic but persistent emotion. In addition, paleontologists often work alone and are slow to communicate the results of their work with others.

This problem is especially critical in the National Park Service where duplication of efforts is likely but should be avoided and where resources are limited and must be protected. For example, a graduate student conducting taxonomic research on phytosaurs at the Petrified Forest National Park would be in trouble if another phytosaur specialist refuses to share information on NPS fossils, or refuses to work together.

Solution: Researchers should develop goals that complement others' goals in a fashion that fosters communication between the researchers. Fears of being "scooped" seem always to diminish when communication is open. The park administrators should bring the scientists together, (1) formally through periodic symposia on subjects of common interest, committee assignments for those who are most heavily involved in park research and such devices as newsletter for in-house circulation; and (2) informally through field trips, shared meals, "rump sessions" at annual meetings of professional societies (i.e. Park administrators should attend annual meetings of the Society of Vertebrate Paleontology and regional meetings of the Geological Society of America).

Problem 6: Preparation Follow-Up

Too often, perhaps in the majority of cases, excavations result in what seem to be significant fossils, but once the fossils reach their respective museums they remain unprepared for months and years. Soon their importance is diminished and eventually the existence of the fossils is forgotten. Plaster jackets are the nemesis of every collection manager.

Solution: Every excavation should have a follow-up plan, one that anticipates preparation needs. Park administrators and advisory committees should recognize this critical need for laboratory preparation and curation. In the event that preparation plans are insufficient, the park should consider ways to assist in the preparation through NPS funding or through private support agencies. This bottleneck to research and communication can be avoided with adequate planning and thorough communication between researcher and administrator.

Problem 7: Unprofessional Collecting Practices

Occasionally individuals resort to field practices that are unacceptable to the professional community of paleontologists. Examples are indiscriminate collecting, poor documentation, collection of items not allowed by one's permit and so on.

Solution: Peer pressure is the best deterrent to unprofessional practices. The science advisory committee should be made aware of the problem and recommend to the administration appropriate corrective action.

SUMMARY

Paleontologists subscribe to generally accepted standards of conduct. All are concerned with conservation, preservation, excavation and research and all share common goals. The best way to facilitate productive research is to promote communication. In every instance, lack of communication leads to difficulty. For paleontologists the advantages of working in National Parks are many but few have been willing to venture into the parks because of prior misconceptions. Productive research is in the public interest and we all benefit.