A Report to

THE RESEARCH RANCH FOUNDATION

on my

1982 SUMMER FELLOWSHIP

for the

"Dendrochronology on and Adjoining the Appleton-Whittell Research Ranch"

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DENDROCHRONOLOGY ON AND ADJOINING THE APPLETON-WHITTELL RESEARCH RANCH

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It would not be correct to call this a terminal report, in that my interests will carry on well past this date. I regard the present chronology building stage as a pilot study. The basic control data - established (but not necessarily published or immediately available) tree-ring chronologies, both modern and archaeological, for central and southern Arizona and northern Chihuahua - have been amassed and made usable.

Collections of a new dendrochronological species, Mexican Pinyon, Pinus cembroides, have been made and the material demonstrated as usable. This report incorporates, updates, and expands my progress report submitted 30 August, 1982, and the data included in my application for the 1983 fellowship.

In the application for my 1982 TRR Fellowship, I proposed:

1. To synthesize a composite regional tree-ring chronology and to establish one or more chronologies for the Huachucas.

2. To conduct exploratory studies of the tree-ring potential of suggested shrubs and non-conifers on and adjoining The Research Ranch. A stem herbarium for the ranch would be established and the dendrochronological qualities of each species would be given.

3. To consult with resident staff, graduate students, and visiting scholars, both at the Ranch and at the Laboratory. Students and perhaps staff from the University in Tucson would be taken to the Ranch to further interdisciplinary discussions and to perhaps promote their interests in research on the Ranch.

Summary of Results:

1. Results of the basic objective, to establish a tree-ring chronology suitable both for a dating control for a new dendrochronological species and for climatic reconstruction at The Research Ranch, are presented in a following section.

2. The restriction against collecting live material on the Ranch has slowed the preparation of an annotated stem herbarium. Some sections have been collected from identifiable dead material, however, and a limited collection has been made and examined. A file of photocopied descriptions, from such references as Benson and Darrow (1981), is being prepared for major plant species found on the Ranch.

3. Consultations and visits:

I consulted with Bill Kenney, a graduate student from the University of Colorado, at The Research Ranch in regard to his study of Bacharris sp. and examined some of his stem sections in the laboratory. Steve Stein, a graduate student from the University of Colorado, attended the Tree-Ring Orientation Program in October 1982 to further his studies on fire history. On 17 August 1982, I presented a progress report on my ring studies at the weekly seminar at The Research Ranch.

I have been accompanied in the field by Michael McComas, Graduate Assistant in Research at the TRL and a UA graduate student (Ph.D. program); Martin Rose, TRL staff member and graduate student (Ph.D. program); and Wu Xiang-ding, Institute of Geography, Beijing, China (now a visiting scholar at the TRL). Kenneth Cole and Carl Bock recently accompanied me into the Mustang Mountains to investigate packrat middens in cave sites.

As a result of these visits, Mr. Rose submitted a proposal for a 1983 TRR Fellowship on "Climatic Variability and Reconstruction in The Research Ranch Region" and Dr. Cole one on a study of the "Late Quaternary Vegetation of the Mustang Mountains."

Literature Review:

Schulman (1956) reported difficulties in dating, especially in pinyon, at low elevations and southern latitudes. Both Edmund Schulman, and A. E. Douglass before him, arrived at this conclusion through experience and deductive reasoning.

In regard to the Gila River Basin, Schulman (1956) says that: "Although coniferous trees may be found which provide tree-ring histories of rainfall fully as sensitive as the best records farther north, these histories are neither as long nor as easily derivable. The long recognized tendency of trees in lower latitudes to lay down false annual rings is quite strong in some species in this basin, particularly in the drought-sensitive stands near the lower forest border; on some sites, these and other complex or varying ring structures make precise ring-dating very difficult or quite impossible. These qualities are particularly pronounced in the pines. It is now recognized that the average ages and maximum longevity of trees in this basin are markedly less than in the same species farther north. For these reasons, the well based chronologies in this region thus far developed extend backward only about three centuries."

Fritts (1976), after joining the staff at the Laboratory of Tree-Ring Research in 1960, embarked on an extensive program to examine and test the fundamental basis of such prior work. As it turned out, all major principles and concepts originally formulated by the founders of the discipline proved correct. Results of his tests and the botanical basis for them are treated in his book.

Elias (1980) describes Pinus cembroides as occurring from 5,200 to 8,200 feet in elevation; Little (1980) from 5,000 to 7,500 feet, locally to 2,500 feet.

The distribution of P. cembroides on The Research Ranch is described and shown on a vegetation map by Bonham (1972).

A geologic map of the Huachuca and Mustang mountains was prepared by Hayes and Raup (1968).

Bahre (1977) presented a land-use history of The Research Ranch.

Background:

Long before there was a Research Ranch, I conducted research in the area. In conjunction with a tree-ring survey of the Gila River drainage, I collected cores from Douglas-fir in the Huachuca Mountains. In an evaluation of the growth-ring potential of shrubs and non-conifers I collected specimens of cliffrose in the Canelo area, etc. Thus, it was easy for me to focus on the potential of applying dendrochronological studies to the climatic and ecological interpretations of The Research Ranch.

My attention was first drawn to the Mexican pinyon in Post Canyon by Jane and Carl Bock. This unique site was documented by Bonham (1976). My initial sampling of the pinyon consisted of increment cores. I found that the trees were relatively young and that, because of the high percentage of false rings, I could only pick up the dating in portions of the cores. The obvious recourse was to collect cross sections from dead and down trees and/or to collect both cores and sections from upper elevations. In any case, we would need the existant tree-ring chronologies for control.

The application of a dendrochronological study is dependent upon the availability of one or more suitable species and the time and experience necessary to collect, prepare, and study the material. The species I chose had not been documented, so I first had to go through an exploratory phase.

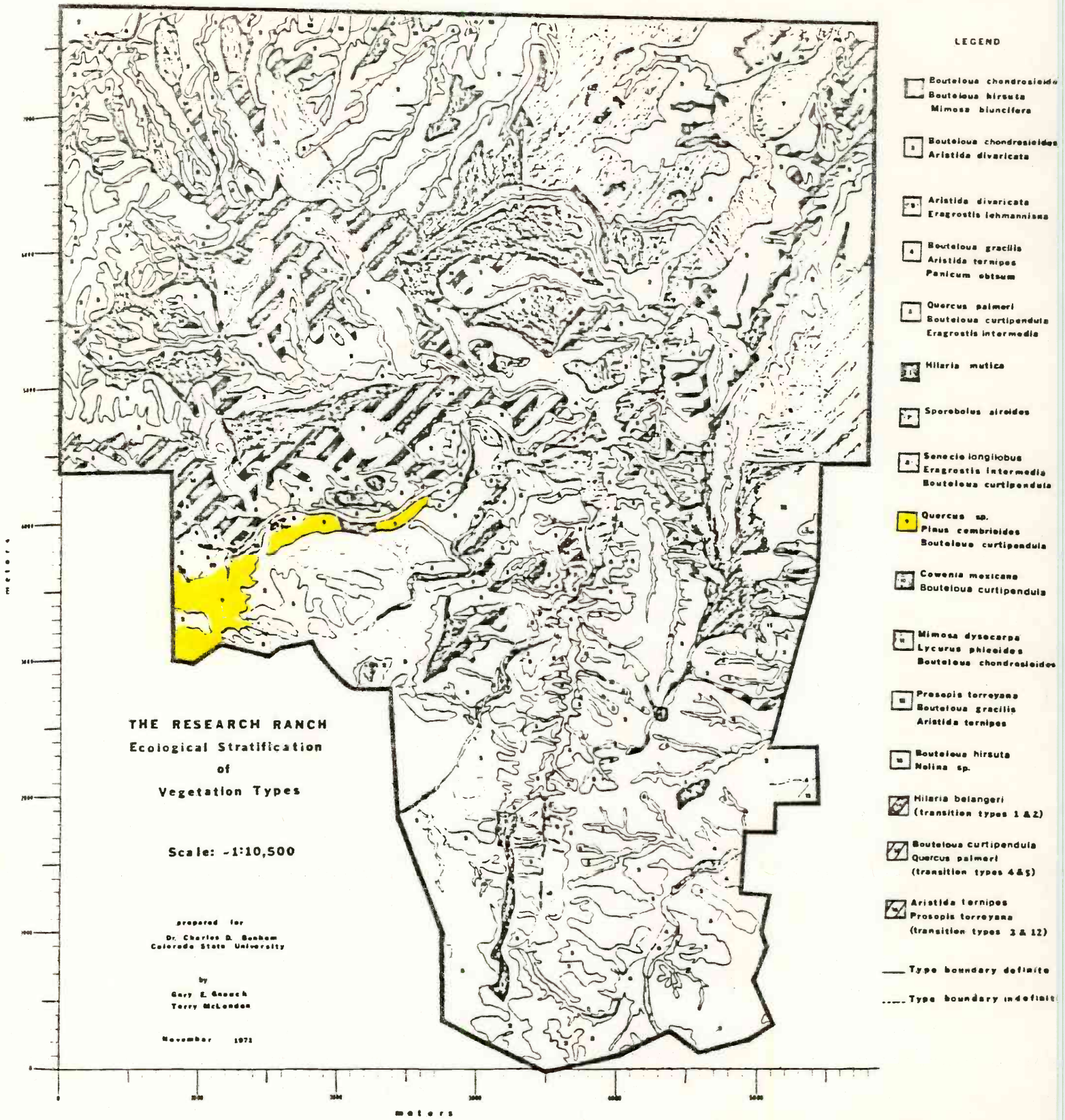

Fig. 1. Location of Mexican Pinyon in Post Canyon on The Research Ranch (adapted from Bonham, 1972).

Dating Controls:

Seven chronologies, for separate mountain areas, constitute the oldest records in southeastern Arizona. These in Table 1, are from the dendrochronological series for southeastern Arizona and are available at the Laboratory of Tree-Ring Research in plotted form. The Rose Peak chronology is the only one based on ponderosa pine; the others are all Douglas-fir. Schulman (1956) reported a Rose Peak chronology back to 1603. The Santa Rita chronology has been the single most valuable control. The others serve to substantiate. All sites are in need of re-collecting in order to compare with weather data for the past few decades. Note that the Huachuca area is not included; only a minimum chronology back to 1800 exists (Schulman, 1956). A few dated but unreported cores go back to the 1500 and 1600's and provide some evidence for the potential for the Huachuca Mountains.

These modern chronologies were augmented by the inclusion of the southern-most archaeological tree-ring chronologies in the state. These areas, Central Mts., North and Central Mts., South, have modern components at Showlow and Grasshopper (Table 1).

Scott (1966) reports two chronologies from northern Mexico: an archaeological chronology from Casas Grandes and a living tree chronology from the Sierra Madre (Table 1).

Table 1. Master chronologies used as dating controls for the Huachuca Mountain area.

Area	Interval, A.D.
Rose Peak	1660 to 1965
Galiuro	1650 1965
Chiricahua	1647 1969
Pinaleno	1625 1967
Rincon	1621 1972
Santa Catalina	1526 1968
Santa Rita	1414 1942

Central Mts., South	1096-1385	Grasshopper	1642-1971
Central Mts., North	965-1381	Show Low	1596-1972
Casas Grandes	350-1336	Sierra Madre	1524-1961

Dated Specimens of Mexican Pinyon:

The temporal placement of each specimen that has been completely or partially dendrochronologically dated is given in Table 2. Carr Canyon is represented by a single specimen. The rest are from Post Canyon. Difficult intervals were solely ring counted. As our understanding of the local chronology (as contrasted to the regional chronologies used as dating controls) increases, more and more of these difficult intervals can be dated. The same holds as more and more specimens are located and dated.

The data presented in Tables 1 and 2 have been expressed graphically for the poster display prepared for The Research Foundation banquet, 23 March, 1983. Ultimately, this graph will be photographed and presented as a page-sized figure.

The plotted indices for Central Mountain South and Central Mountain North show excellent visual crossdating for the 266-year interval of overlap. Critical rings in these correspond with critical rings in the Casas Grandes series, thus providing a composite chronology that should apply in The Research Ranch area. The same is true for the modern components and the southern Arizona material in general.

A dated cross section from Post Canyon is shown in Fig. 3.

Table 2. Dated remnants.

Area	Interval, A.D.		
Carr Canyon	1635	to	1763
Post Canyon	1347		1900
	1513		1676
	1550		1820
	1590		1833
	1590		1731
	1612		1838
	1631		1821
	1635		1759
	1635		1753
	1652		1829
	1679		1822
	1843		1967
	1892		1967
	1900		1967

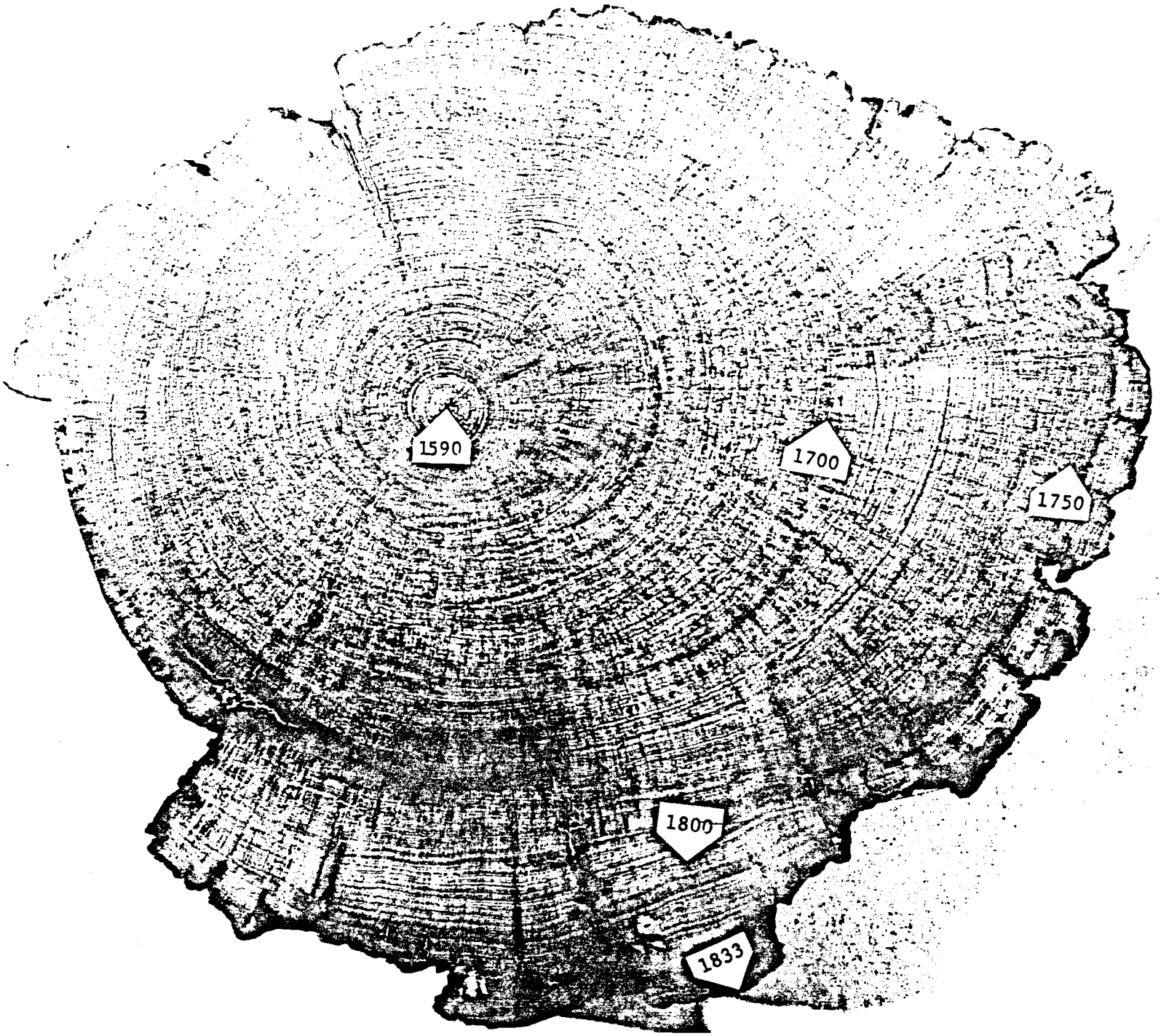

Fig. 3. Dated cross section, A.D. 1590-1833, of a pinyon remnant from Post Canyon, about 9/10 actual size.

Carr Canyon Pinyon Remnants:

The first pinyon remnant to be dendrochronologically dated, from A.D. 1635 to 1763, was from 7,200 feet at the head of Carr Canyon. Raw ring m easurements are shown in comparison with the southern Arizona Douglas-fir master chronology (Schulman, 1956) in Figure 2.

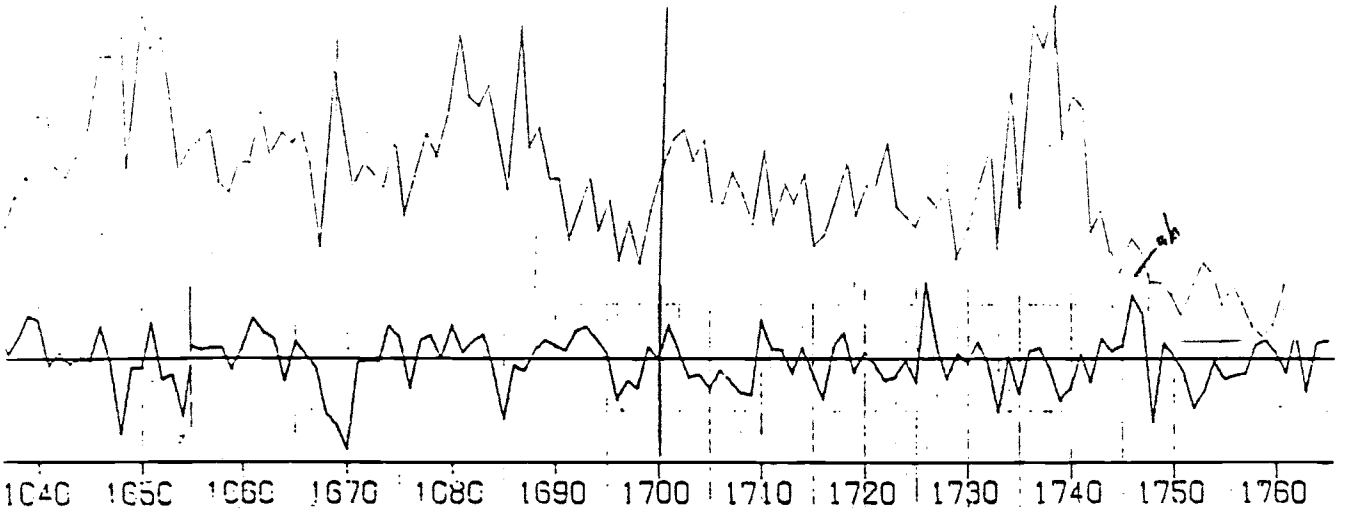

Fig. 2 Carr #6 (upper) in comparison with southern Arizona Douglas-fir. Note the small rings for 1648, 1685, 1733, and the absent ring for 1748 in the pinyon.

Post Canyon Pinyon Remnants:

The first pinyon remnant found in Post Canyon was called to my attention by my wife, Eileen. We were on a tour to the Post Canyon dam, with the Bocks and others. Sections of the piece were collected later with the aid of Vernon Hawthorne and his chainsaw. When the sections were sanded and examined, my impression was that the material was too loaded with false rings even to be seriously considered datable. However, with the passage of time and the subsequent dating of five or six

of the Post Canyon remnants, I went back to the original material and (on the evening of 5 Feb. 83) immediately picked it up on the 1733, 35, 48, 53, and 63 signature. It was totally datable, and spanned the interval A.D. 1652 to 1829.

Because the Mexican pinyon has the problem of both false rings and locally absent or missing rings, the initial effort was to collect cross sections from dead and down trees. This permits one to follow a given ring about the circuit to verify its annual nature. Thus, with a chronology established, the single radius, represented by an increment core, can be dated. Secondly, by using the rather resistant dead wood, the chronology may be extended by crossdating and incorporating into the chronology successively older and older material.

In form, the stumps and remnants can roughly be divided into two general classes: those with a weathered outside (still in a full-circuit cross section) and those with a dissected and eroded form. The latter have a much greater expected age. These physical characteristics serve as a guide in the location of old wood (Ferguson, 1971 and 1979).

Remnants are long-lasting because they are resinous and usually their resistant quality is due to the presence of a knot, scar tissue, or root area. These features tend to modify growth form in a non-regular way. These, and the tendency of pinyon to show growth surges does not make for ideal material for climatic analysis. This can be overcome, however, by selection of an ideal radius, level of section, or better specimens.

The oldest Post Canyon pinyon, well dated in the early 1700's, contains about 554 rings, making it the oldest known tree in southern Arizona. And since it died (or was cut) about 1900, it contains some of

the earliest datable tree rings in our area. On a ring count basis prior to A.D. 1510, the specimen goes to 1347, to within perhaps 10-15 years with the Casas Grandes archaeological chronology. The modern Sierra Madre chronology, extending to 1524, has been exceeded by the pinyon, thus shortening the gap of 188 years between the archaeological chronology and that of the modern material.

Cross sections were taken from three dead and down pinyon in Post Canyon that had the appearance - size, age, and bark deterioration - of having been blown over by a strong windstorm following a soaking rain. A neat thought,but in the initial examination of the polished cross sections, I could not get any crossdating. Then, discarding my preconceived notion, I approached the dating of each one as an individual. I recognized the 1921, 3, and 5 sequence in one specimen and soon in all three. The sections were contemporaneous with apparently the same bark date. Mike McComas worked on the details to determine both the pith and bark dates. The pith dates (Table 2) were 1900, 1892, and 1843. The bark dates seem to be the same, 1967, but the very outside was difficult to see.

Evidence of Long-term Climatic Change:

From many areas of the Ranch, The Mustang Mountains tend to dominate the view. Perhaps, too, they dominate our thinking, certainly our general interest. Their cliff-like summits seem to offer challenges. Upon reflection, they may even offer some solutions.

Records of long-term climatic change can be detected by the study of plant materials in packrat middens protected for millennia in dry caves and dated by radiocarbon analysis. These deposits from the recent geologic past - the post-Pleistocene and Holocene Periods, representing the 20,000 years since the last glacial, or pluvial period in our area - are often found in dry caves. And the Mustangs seemed to have some good cave sites. When extra-local plant species are found and dated by radiocarbon, an elevational change of 2-3,000 feet may be shown and a corresponding climatic change indicated. Ken Cole and Carl Bock accompanied me to a cave area at the base of the cliff on the south slope below Mustang Peak in The Mustang Mountains. Two middens collected by Dr. Cole were estimated to be 1000 to 5000 years old.

Archaeological Relationships:

The Casas Grandes archaeological site (DiPeso, 1974) is less than 200 miles east-southeast of The Research Ranch. The tree-ring chronology for the site, A.D. 850 to 1336, was based upon crossdating with well established chronologies in northern Arizona and New Mexico. It would be worthwhile if a more local control could be established. The Post Canyon material, based upon a ring count prior to A.D. 1510, is within 10-15 years of the Casas Grandes archaeological chronology. My first familiarity with an archaeological tree ring was with A.D. 1005, a small ring in the middle of an open series. This mini-signature was recognizable in the Casas Grandes chronology and gave me added confidence in the Casas dating.

DiPeso (1951), in his report of the Babocomari Village Site, described charred posts in place, but at the time of writing no tree-ring dates had been obtained. The site is on the Babocomari River southeast of the Mustang Mountains at an elevation of 4,429 feet. Using trade ware (pottery), DiPeso suggested that the Babocomari period ended about A.D. 1500. The posts were described as juniper and Chihuahua pine; neither species has a good dendrochronological reputation. However, pinyon would have been available and, if used, could possibly be dated against the Casas Grandes archaeological chronology or the earlier pinyon from The Research Ranch area. Jeffrey S. Dean (personal communication, 8 March 1983) reported that the tree-ring samples collected at the site numbered 94 and were on deposit at the Laboratory of Tree-Ring Research. The smaller samples were described as charcoal and the post remnants as charred. Species descriptions were mostly "Pine", with "Juniper" constituting a lesser amount. At least one "Pinyon" was listed.

I question the Chihuahua pine designation in DiPeso's report, and suspect that there may have been more pinyon than was thought. None of the Babocomari Village specimens have been dated.

Summary:

Three basic questions have been answered. First, cores from pinyon below 5,000 feet are nearly impossible to date without species (cross sections) or regional controls. Second, it has been found that full cross sections can usually be dated. Third, a source for readily datable pinyon has been found above 7,000 feet. This makes the procedure obvious: build a chronology from the upper elevation; use it as a control to date the low elevation pinyon sections; then, use these to date the low elevation cores.

These steps have been partially undertaken and it seems that the desired objectives — to strengthen and extend the tree-ring chronologies for the Huachuca Mountains and southeastern Arizona in general -- are feasible. Well-documented regional chronologies would be necessary as a base for climatic reconstruction.

Exploratory collections have shown the feasibility of using increment cores for age determinations of cottonwood, as in Post Canyon, and sycamore, as in Lyle Canyon.

Plans for the Future (as time and money permit):

1. The Post Canyon area will be revisited to collect additional sections from known specimens and further search will be made for additional material.

2. A second reported pinyon site, just south of the Ranch, will be examined.

3. With the disappearance of the snow and improvement of road conditions, the Carr Canyon site will be revisited and collections will be made of previously located pinyon remnants.

4. The best possibility for chronologies from living pinyon trees seems to be in Huachuca Canyon, where collections will be made.

5. Dated series will be measured and computer plots derived.

6. Other species will be collected and processed.

Plans for Publication:

Final chronologies will be submitted to the Laboratory of Tree-Ring Research and to the International Tree-Ring Data Bank.

In that the Huachuca area is a void in the network of established tree-ring chronologies for the Southwest and in that Mexican pinyon is an unreported dendrochronological species, suitable outlets will be sought for publication when this study is finished.

Acknowledgments:

The interest and support of others has been of direct assistance to the project and I would like to acknowledge a few. My wife, Eileen, and daughter, Erica, have been with me on many of my trips to the Ranch. Michael G. McComas, my lab assistant, has been with me in the field and has assisted in the preparation, examination, measurement and verification of the specimens. The "second opinion," necessary for the verification of dates, has been provided by Thomas P. Harlan, a Research Associate at the Laboratory. The modern and archaeological chronology controls, in the form of plotted tree-ring series, have been provided by G. Robert Lofgren and Michael S. McCarthy, in our data processing section. Dr. Carl Bock, Dr. Kenneth Cole, Mr. Martin R. Rose and Mr. Xiang-ding Wu have assisted me in the field. Vernon Hawthorne, the Ranch manager, and his wife, Nancy, have been wonderful hosts and Vern has been with me in the field.

Most importantly, I wish to thank The Research Foundation for the 1982 Summer Fellowship, which provided me with financial support and encouraged me to focus on the dendrochronology of The Research Ranch and the nearby Huachuca Mountains.

Permission to collect tree-ring material in the Huachuca area has been secured from the U.S. Forest Service, Sierra Vista Ranger District and the Department of the Army, Fort Huachuca. Permission has been secured from the Rose Tree and Babocomari ranches to search for and collect from packrat middens in the Mustang Mountains.

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