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A Preliminary Study of Andean Wood

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Statement of Purpose

Conduct a preliminary study of known wood samples from species in the area of archaeological excavations at Chiripa, Bolivia conducted through the Taraco Archaeological Project (TAP) from 1992 to 1999, with an intention of eventual identification of unknown archaeological wood specimens.

Introduction

Chiripa lies on the Northern shore of the Taraco peninsula on a slope rising up from the Lake Titicaca basin. From what we know from previous excavations of the Chiripa site by Max Zamora in the 1930's, Alfred Kidder III and Gregorio Cordero Miranda in the 1950's and David Browman in the 1970's, it was an important center during the early Formative phase of Bolivian prehistory. The Formative phase ranges from 1500-100 B.C. (Hastorf 1999). This is a time of increased human occupation on the high altiplano. We find the beginnings of nucleated communities for the first time, the occurrence of domesticated plants, new ceramic technologies and permanent architecture. This region soon became the location for Tiwanaku, the longest-lived center in the pre- Colombian Andes. The focus remains on the Formative period because of the drastic changes that must have taken place to transform the region into a major cultural center and the people that initiated these changes. The primary goal of these most recent excavations was to gain a greater understanding of the daily life and use of resources to perhaps better understand these people.

Studying botanical remains collected from the site such as wood is essential to understanding the relationship ancient people shared with their environment. Some common wood types are already known from previous studies such as Buddleja, Polylepis, Alnus and Colletia, which gained a foothold after the Inka conquest of the area. However, even with this knowledge, comparatively little work had been done in the Andes, partly due to the scarcity of trees. Few published anatomical studies of Andean economic trees exist, much less of the small shrubs, bushes and woody annuals often used for everyday fuel, tools and shelter. Creating or finding a complete collection for reference is difficult. The current state of available wood types in the altiplano is also practically non-existent due to deforestation and over grazing. The current most abundant wood type seen is the introduced species of eucalyptus, which resists predation by the production of noxious oils and resin in the leaves and sap. The next most common wood is from the species Buddleja, but these specimens are only found in or around house compounds making it difficult to collect these specimens due to the precious nature of the trees for economic and cultural purposes. Other tree types found in the area around Chiripa are introduced pines and cypress species; these also resist predation by grazers due to their unsavory flavor. These trees are specifically owned and managed by the local residents of the town and are virtually off limits to sampling without special permission. Only two or three examples of the species Polylepis can be found in the area, one example is to the east of Chiripa about 2 kilometers from the road in a deep canyon, this tree is held as a sacred plant, and is one of the best examples of this species found in the area. The other examples of Polylepis are to the east again away from the road in deep canyons not easily accessible for opportunistic fuel gathering.

The most common fuel used in everyday activities is animal dung (cow and guinea pig), with wood reserved for more prestigious occasions where large and hot fires are required for communal cooking. Charcoal production is not practiced to any extent and in some areas propane is replacing solid organic materials for heat and cooking purposes. It is assumed that charcoal found in the archaeological context is from the incomplete burning of the fuel source, in a reducing environment. Wood is rare at the archaeological site of Chiripa, out of 258,000 identified organic specimens only 10,500 are pieces of wood over 2.0 mm (4% of the total). We can easily interpret this pattern in the following ways, wood was as rare as it is today, wood was not the preferred fuel resource, or wood was burned in such a way as not to produce charcoal. We would like to assume that wood was rare and we are seeing a similar pattern of wood availability and use as today. Our ultimate aim is to positively identify the unknown wood samples from this site against a small reference collection using the knowledge we have of common Andean wood types. We draw heavily on the previous work completed by Sissel Johannessen and Prof. Christine Hastorf in a small study of Andean wood types and species from the nearby site of Tiwanaku. With this study we hope to add to the knowledge of botanical species common in Andean prehistory.

Methods and Materials

In preparation for the study, samples from the known reference collection were removed that were representative of common wood types. These were Berberis sp., Berberis sp. #2, Lupinus sp., Chenopodium quinoa, Alnus sp., Polylepis sp., Buddleja sp., and Schinus molle. A total of eight samples were prepared by first cutting with a razor to photograph different views. Fixation was not required for the wood samples because they had been found in a charred state, almost 90% carbon by weight. The samples were then mounted onto stubs using carbon dots and sputter coated with gold-palladuim to a layer of 30 nm. Using an ISI-DS 130 Scanning Electron Microscope, several photographs were taken of each sample to obtain the highest quality image of the cell structure and overall pattern of xylem layering.

Next, eight of the most relevant samples were chosen from the unknown collection. These were Flot numbers 10382, 10500, 10136, 10378, 11346, 11288, 11361 and 11382. We had hoped to use more in the study, however time constraints prevented this. These samples were also mounted onto stubs and sputter coated to a layer of 15 nm. Photographs will then taken of these and compared with the photos of the know samples in the near future.

Results

When examining the wood sample photographs there are several standard characteristics that we observed in order to make accurate comparisons. Some are easier to observe with the aid of an electron microscope and others are not. To determine color and odor, microscopic pictures are obviously not needed. In addition, there are different types of cells that can be observed in living wood that help with identification such as parenchyma, vessel elements and fibers. However, the samples we are observing are charred and that cell information is lost (Cote 1979). We do not have living tissue structures as identification markers so we can only use structure in the hard cellulose structures and the overall patterns of vessel and xylem growth.

There are three main sections that can be created in a wood sample and it is ideal to capture all three on one photograph. A cross-section is produced by cutting across the wood perpendicular to the stem. Cutting longitudinally from the stem to the bark creates a radial section. Finally cutting tangentially to the bark and perpendicular to the wood rays produces a tangential section. We attempted to produce all three of these sections in each sample.

For our purposes, there are only a few characteristics that we took note of, partly due to the charred state of the samples and partly due to the information in the photographs. These criteria mostly concern cell structure and distribution. "Wood rays" are identified by the cellular patterns of ribbons of tissue that radiate out from the center to the outer bark. In some species they are only a few cells width, but in others they are much thicker. The width of a ray can be seen in the cross section and in the tangential section. In the tangential section the height and the width can be seen. (Cote 1979).

Grain or texture can also distinguish between species. This quality refers to the sizes of various cells in the wood and direction of fibers in relation to axis of the tree stem.. So, along with "rays" and "grain or texture" another possible feature to observe is "ring-vs. diffuse-porous." This characteristic can be applied to hardwoods from temperate zones. Generally, two broad groups, ring-porous and diffuse-porous are used based on the change or lack thereof of pore size across the growth ring. Ring-porous woods show a clear difference in pore size in the early portion of the growth ring as opposed to the latter. Diffuse-porous woods have pores that look the same regardless of their position in the ring (Cote 1979). Because we are dealing with tropical woods some of the identification characteristics do not apply. In the altiplano we have a marked wet versus dry season, but not a marked freezing versus hot, which creates the characteristic ringing in deciduous trees. Growth occurs during most of the season but at differential rates, this is an unfortunate predicament for wood identification.

Pore arrangement refers to patterns of cell distribution in the wood. These are uniform, ulmiform, dendritic, radial and nested. For our purposes, it is worth mentioning that Alnus exhibits radial lines to an extent. Pores can also be single or in multiples which we also see in many of the samples. Below is a table that summaries the results of three characteristics we found to be useful for all eight species. The SEM photographs used to create this table are found at the end of this report.

Distinctive Characteristics of Each Species

Species	single pores	multiple pores	clear rays	unclear rays	diffuse-porous	semi-ring porous	unclear porosity
Alnus		*		*	*		
Budleja	*	*		*	*		
Chenopod quinoa				*			*
Berberis		*	*			*	
Berberis #2		*	*	*		*	
Lupinus		*					*
Schinus molle		*	*				*
Polylepis	*		*	*	*		

Discussion

Because this is a preliminary study, we focused our attention on gathering information on the known samples in order to better identify the unknown. We hope to complete the research next semester and photograph and identify the unknowns. In addition, our time was cut short significantly due to technical difficulties. In conclusion, the photographs we have of the known samples exhibit a number of features useful for future identification. Our next phase of study will be to create another set of known sample photographs and begin the process of sampling the archaeological specimens for possible identification.

References

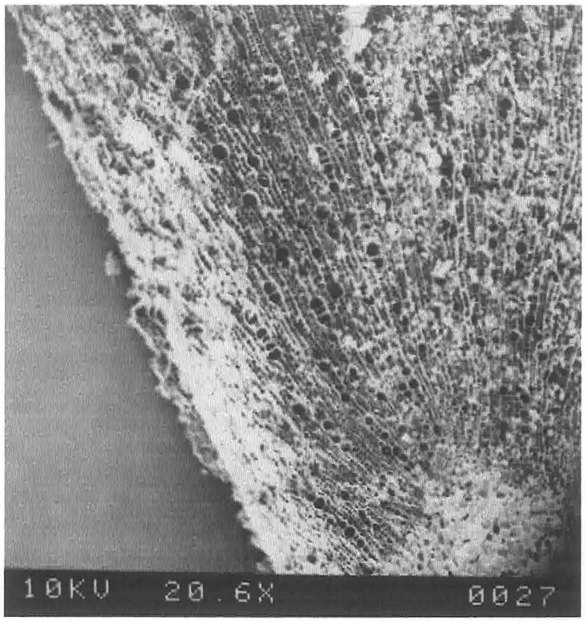
Bozzola J.J. & L.D. Russell, (1999) Electron Microscopy, Principles and Techniques for Biologists, 2nd ed.

Cote, Alfred A., Wood Structure and Identification 2nd ed., Syracuse University Press 1979

Hastorf, Christine A. Early Settlement at Chiripa, Bolivia. Contributions of The University of California Archaeological Research Facility, Berkeley. No. 57 (1999).

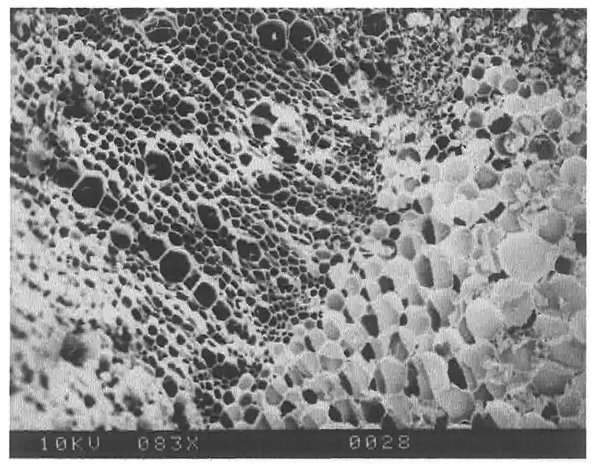
Johannessen, Sissel & Hastorf, Christine, Late Prehistoric Wood use in an Andean Intermontane Valley, Dept. of Anthropology, Univ. of Minnesota. Minneapolis, MN

Plate 1. Alnus sp.
Plate 2. Berberis sp.
Plate 3. Budleja and Chenopodium sp.
Plate 4. Polyepis sp.
Plate 5. Lupinus sp and Schinus molle.



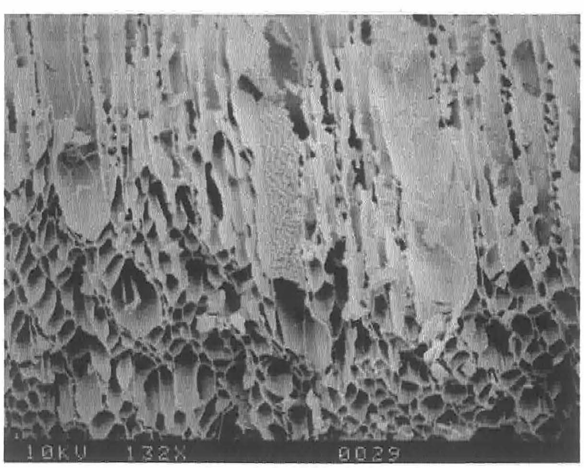
Alnus sp. 268 µ

Figure 1. Cross-section



Alnus sp. 66.3 µ

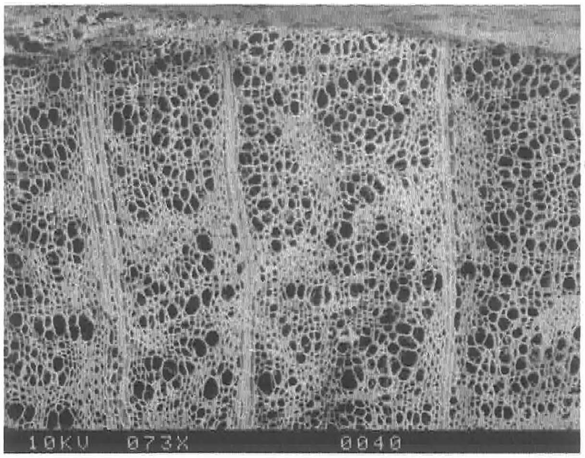
Figure 2. Cross-section detail



Alnus sp. 41.9 µ

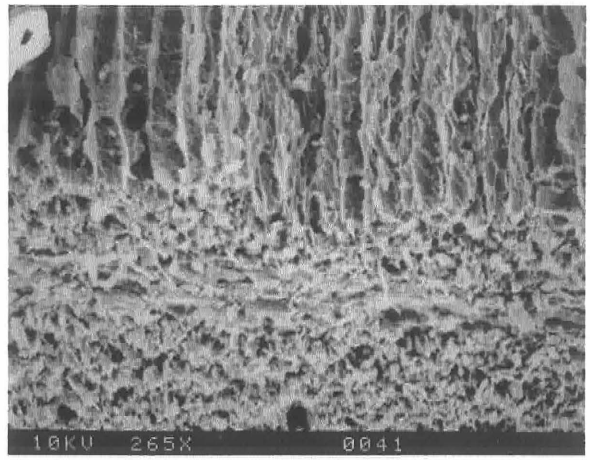
Figure 3. Tangent

Plate 1



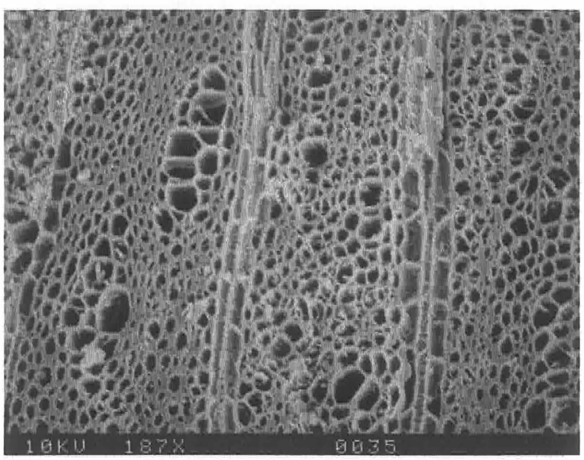
Berberis sp. 75.7 µ

Figure 4. Cross-section



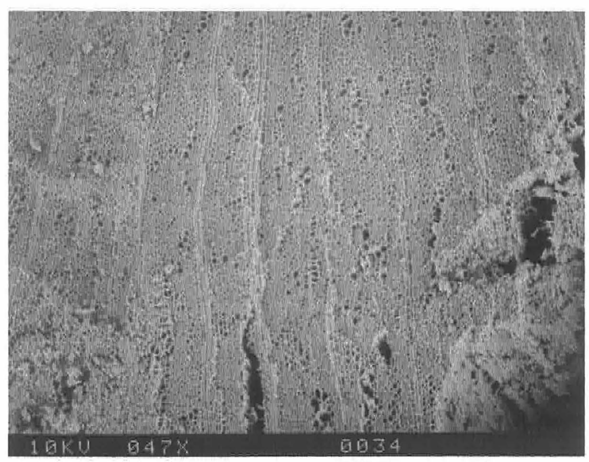
Berberis sp. 20.8 µ

Figure 5. Cross-section and radial



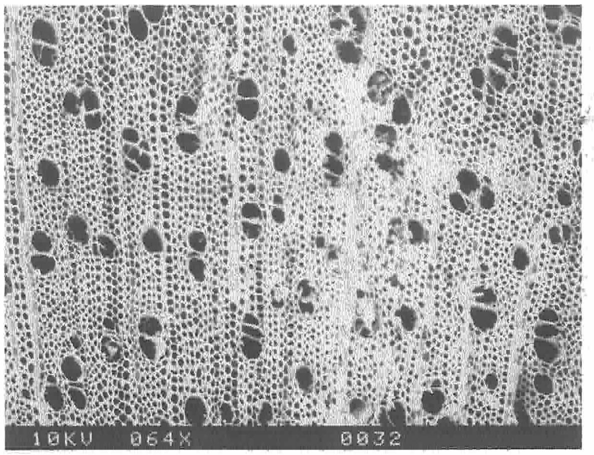
Berberis sp. #2 29.6 µ

Figure 6. Cross-section detail



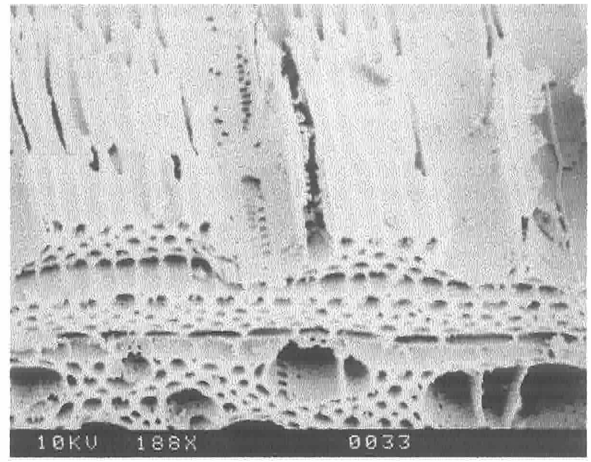
Berberis sp. #2 117.7 µ

Figure 7. Cross-section



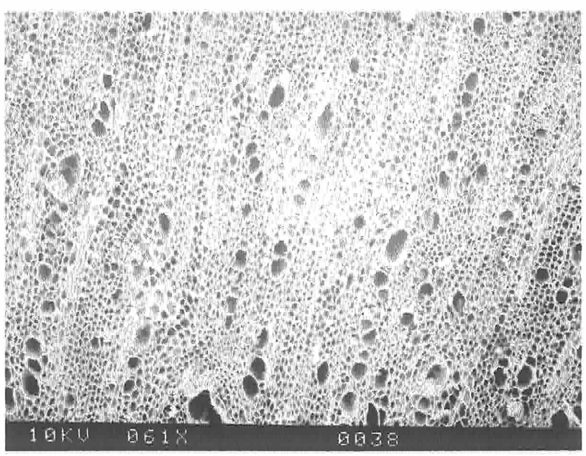
Budleja sp. 86.2 µ

Figure 8. Cross-section



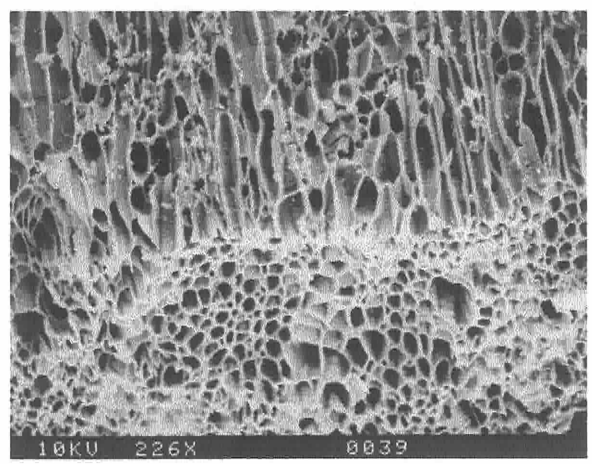
Budleja sp. 29.4 µ

Figure 9. Cross-section and radial



Chenopodium quinoa 90.6 µ

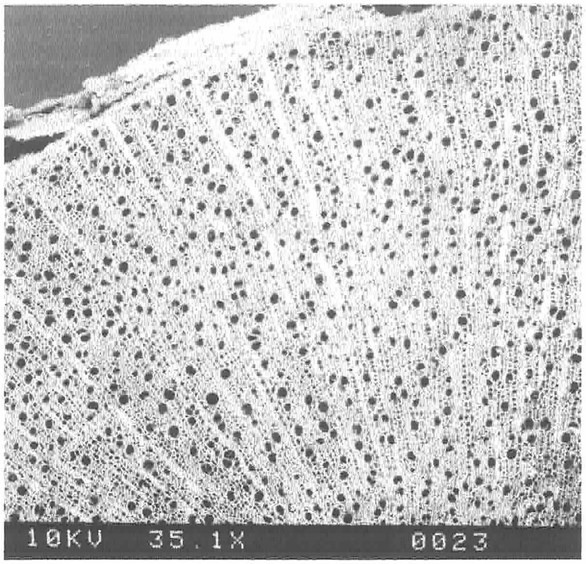
Figure 10. Cross-section with Outer Bark



Chenopodium quinoa 24.4 µ

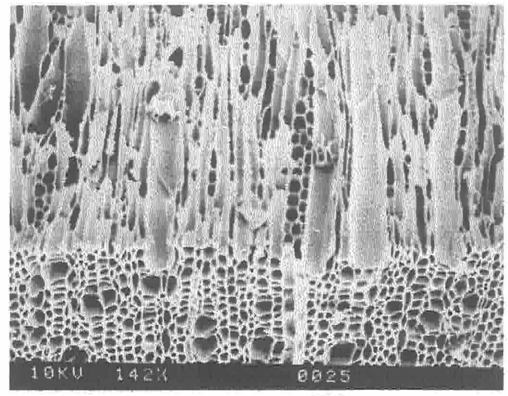
Figure 11. Cross-section and radial

Plate 3



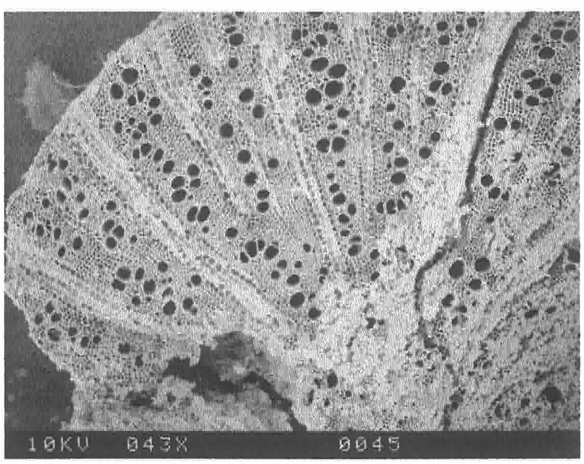
Polylepis sp. 157.5 μ

Figure 12. Cross-section with outer bark



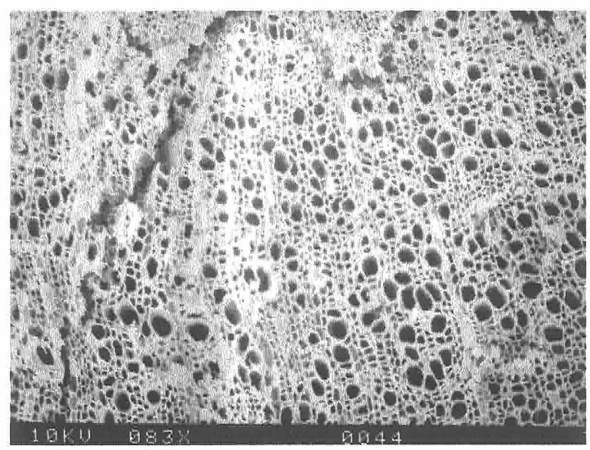
Polylepis sp. 38.9 μ

Figure 13. Cross-section and Tangent



Polylepis sp. 128.7 μ

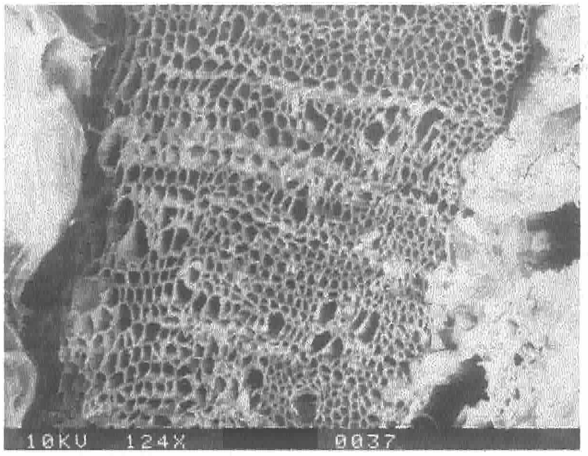
Figure 14. Cross-section



Polylepis sp. 66.3 μ

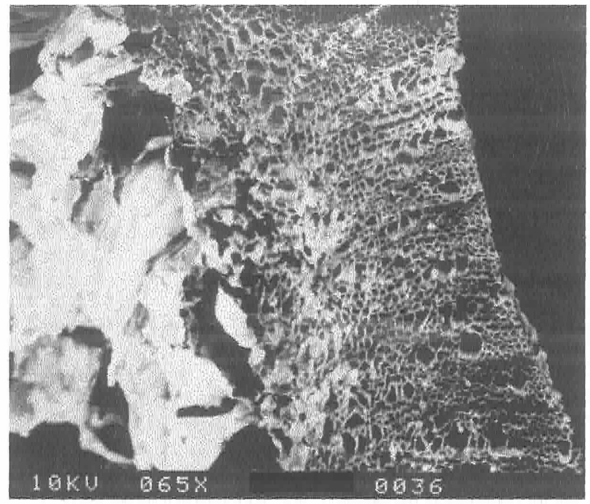
Figure 15. Detail of Cross-section

Plate 4



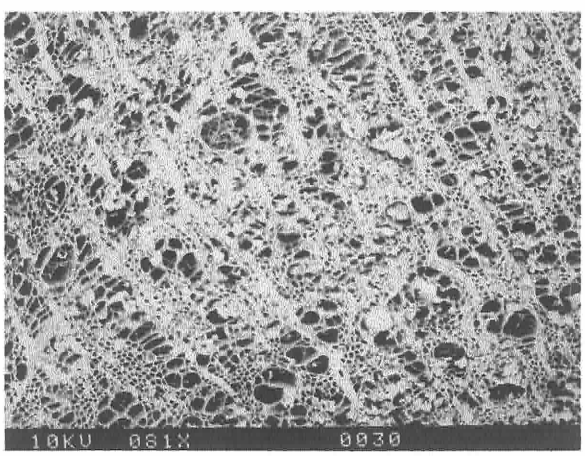
Lupinus sp. 44.5 μ

Figure 16. Cross-section with Outer Bark



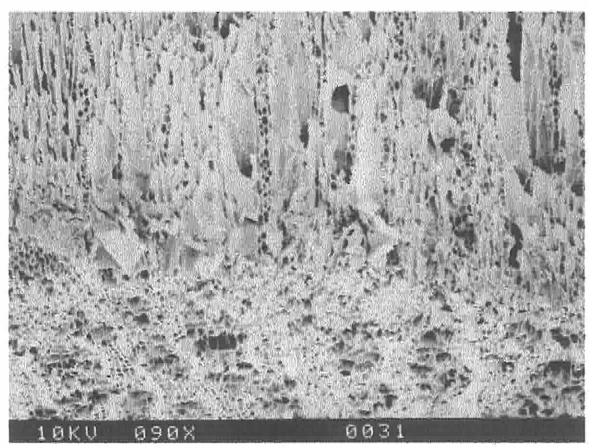
Lupinus sp. 85.1 μ

Figure 17. Cross-section with Outer Bark



Schinus molle 68.0 μ

Figure 18. Cross-section



Schinus molle 61.3 μ

Figure 19. Cross-section and Tangent

Plate 5