# CHAPTER 7

# EXPERIMENTAL TOOL REPLICATION AND USE

## 7.1 Introduction

Experimental, "actualistic", or "imitative" studies are considered to have potentially strong explicative potency with regard to understanding and determining prehistoric behaviour (see Ascher 1961; Ingersoll, Yellen and Macdonald 1977; Tringham 1978; Stafford and Stafford 1979,1983; Kamminga 1982, and many others). They also contribute significantly to the development of "middle range theory" (Binford 1981,1982).

A component of the present study involved replication and experimental use of ten key-shaped formed unifaces in order to secure data concerning their functional efficiency and resulting microwear trace patterns. The information generated by these experiments was then compared with results obtained by the residue and microwear analyses of the prehistoric specimens (Chapters 5.3 and 6), and with tool-use data provided by other researchers. It was reasoned that once all these data were collectively considered, the primary function of prehistoric key-shaped formed unifaces on the Plateau could be inferred through a "best fit" of the comparative results.

## 7.2 Experimental Design

The experiments were guided by several basic empirical observations and assumptions provided by the design theory and prehistoric specimen microwear analyses (Chapters 3.3 and 6.3). First, it was assumed that the primary functional edge of these tools is the concave margin, suggested by its consistently recurrent form, and moderate to pronounced intensity of associated microwear patterns Eassociated with it (Chapter 6.2.3).

Second, the design theory analysis suggested that the main contact material(s) must have been cylindrical (i.e., tubular) in shape, with diameters ranging between about 5 mm and 30 mm, and an estimated mean diameter of approximately 12 mm.

Third, it was surmised that the primary function of these tools involved working of relatively hard contact materials. This is evidenced by the obvious selective preference for hard and durable cryptocrystalline silicates, and the general characteristics and intensity (i.e., moderate to pronounced) of most microwear trace patterns (Chapters 3.3.3 and 6.2; Appendix 6).

Fourth, it was assumed that the primary function of these tools involved two basic motor patterns (i.e., use-motions or "kinematics" [Semenov 1964]) as suggested by the design theory and microwear analyses. These include:

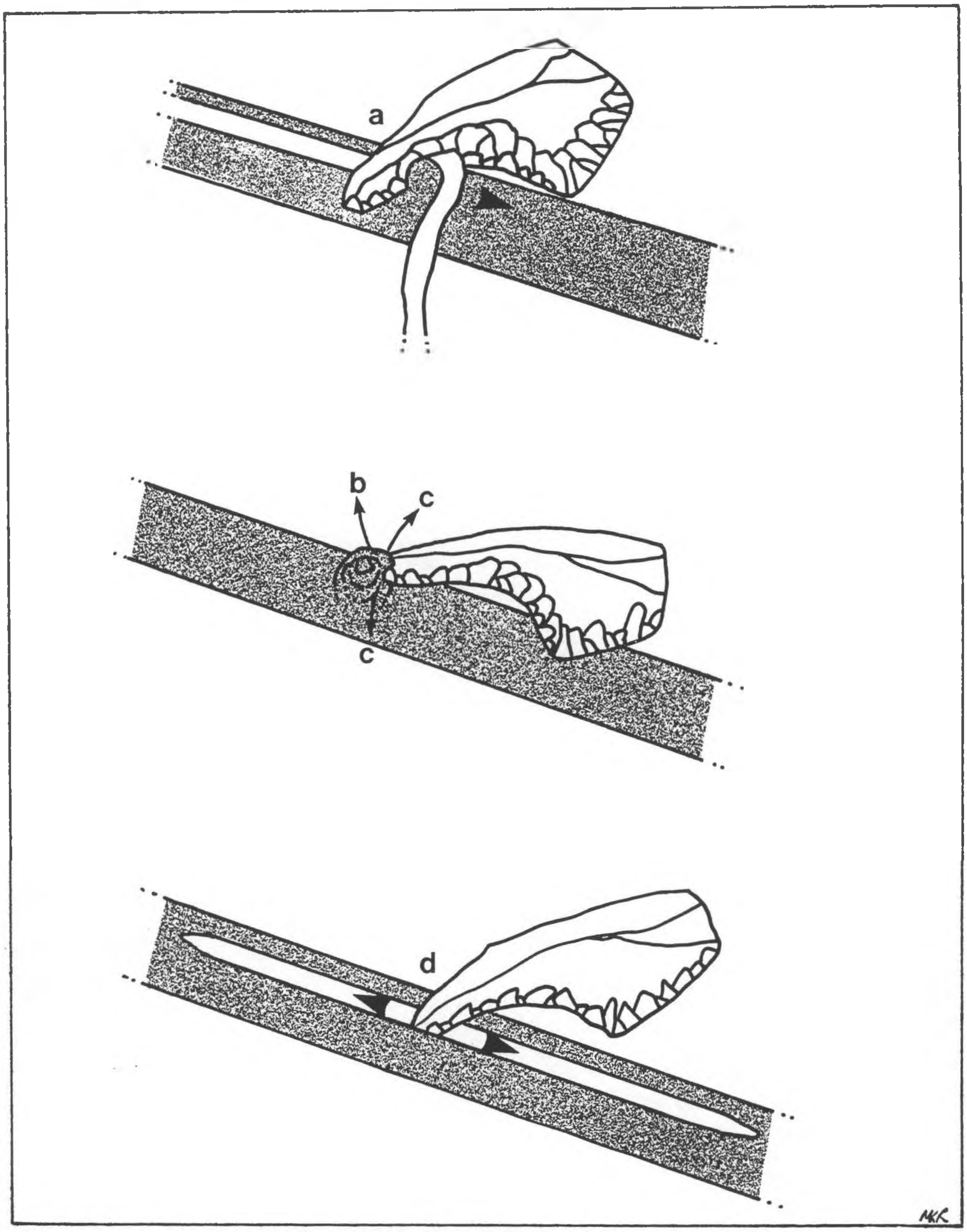


**Figure 9.** Specific task actions mentioned in this study.

(a): Scraping/shaving/planing using the concave margin (shown) and "opposite" margins. Executed to remove bark (shown) and scrape down wood and antler.

(b): Gouging and prying off secondary branch nodes using the distal projection tip.

(c): Lateral side-to-side "sawing" action using the distal projection tip to assist in removing secondary branch nodes.

(d): Graving/incising using the distal projection tip to create grooves in wood (shown) or antler.

(1) shaving/scraping/planing involving primarily the concave margin, and occasional secondary use of the "opposite" margin; and (2) gouging, prying, graving, and incising using the ventral-lateral corners and distal edge of the distal projection tip (Figures 2 and 9).

Fifth, it was presupposed that these items were engaged in working materials that were prehistorically important and available throughout the Interior Plateau and some of its immediately adjacent regions.

Lastly, it was also conjectured that the main reason for working these materials was to produce artifacts that were made with reasonable regularity, and were used by the prehistoric inhabitants of the Plateau for a period spanning at least 2500 years (Chapter 4.2).

Following these assumptions, and given the known range of natural raw materials used by Interior Plateau groups based on the ethnographic and archaeological records, it was deduced that the primary function of prehistoric key-shaped formed unifaces most probably involved working of either: (1) the stalks, branches, and possibly roots, of woody shrubs or small trees; (2) antler beams or tines; or (3) mammal longbone shafts. Consequently, materials from all three categories were secured and worked in the experimental component of this study.

Chalcedonies and cherts were selected to make most of the experimental tools because they have physical properties identical to, or very similar to, those possessed by the majority (88.4%) of lithic materials represented in the prehistoric study sample (Chapter 3.3.3; Appendix 3).

It was reasoned that by holding lithic material types relatively constant between the prehistoric and experimental tool samples, any variation in microwear traces observed between the two samples would not be due to significant differences in physical properties of the lithic materials. Rather, any displayed variability would be primarily attributable to how a tool was used, and on the nature of the contact material(s) worked. This is an important logical consideration of the research design. It allowed the primary function of these tools to be analogically inferred by comparing microwear traces produced on the experimental tools with those borne on the prehistoric study sample specimens without major concern for factors relating to significant differences in lithic material properties.

Cache Creek basalt was used in the experiments to attempt to gain some insights into why this more commonly available lithic material was very rarely selected by the prehistoric inhabitants of the Canadian Plateau for making key-shaped formed unifaces. As postulated in Chapter 3.3.3, this was probably because basalt is softer, less durable, and more brittle than most cherts and chalcedonies, therefore it was not as well suited for executing the primary functional activity associated with this tool type. Use of Cache Creek basalt in the experiments provided an opportunity to evaluate this hypothesis.

The experiments also used several different types of lithic raw materials on the same contact material type (Chapter 7.4; Appendix 9). Stalks and branches of saskatoon were used as the contact material "constant". By holding the contact material constant, it was reasoned that any variability in microwear pattern attributes would be more or less directly attributable to the inherent properties of the lithic raw materials, and perhaps, to the manner the tools were being used. This would provide a better understanding of the physical characteristics, functional efficiency, and relative use-lives associated with each lithic raw material type (Chapter 7.7; Appendices 7 and 9).

Another objective of the experimental design was to explore the effectiveness of traditional hafting methods, and to comparatively assess the functional and mechanical efficiency associated with using hafted and unhafted tools. Tools were used both hand-held and hafted during the experiments (Chapters 7.3, 7.6 and 7.7; Appendix 9; Figures 10 and 42 to 51).

### 7.3 Experimental Tool Replication

Six types of lithic raw materials from sources on both the Canadian and Columbia Plateaux (Appendix 7) were used to manufacture the ten key-shaped formed unifaces used in the experiments (Figure 41).

Lithic material "Type 1" is an opaque, wide-banded duochrome (tan and red-brown), cryptocrystalline chert obtained from northern Oregon (Smith, pers. comm. 1988), used to make experimental tools (E.T.'s) #1 and #2. Lithic Type 2 is a semi-translucent, medium grey-brown, cryptocrystalline chalcedony from somewhere in southern Washington (Smith, pers. comm. 1988). It was used to produce E.T.'s #3 and #4. Unfortunately, the exact source locations for Types 1 and 2 are not known.

Type 3 (E.T. #5) is an opaque, light brown, micro-banded chert from near the town of Falkland in the Canadian Okanagan Valley (Gay, pers. comm. 1988). Type 4 (E.T. #6) is a highly translucent, light white-grey, cryptocrystalline chalcedony found near the community of Pavilion, B.C. in the Mid-Fraser River region. Type 5 (E.T.'s #7 and #8) is a semi-translucent, light yellowish-grey, cryptocrystalline chalcedony from the Upper Hat Creek Valley in B.C.. Type 6 consists of two grades of microcrystalline basalt; fine-grained (E.T. #9), and vitreous (E.T. #10). Both basalts were obtained near the town of Cache Creek, B.C.. Additional details on these lithic materials are presented in Appendix 7.

Traditional and conventional flintknapping tools and techniques were used to manufacture the experimental tools. Direct freehand percussion was employed with a dense hammerstone to strike suitable flake blanks from large multidirectional cores. Ideal flakes were considered to be about 5 to 7 cm long, 3 to 4 cm wide, and .5 to .7 cm thick, and had ventral surfaces that were relatively smooth and flat or slightly concave.

An indenter (pressure flaker) consisting of a wooden dowel haft tipped with 5 mm diameter copper wire was used to form the typical key-shaped outline. This indenter was preferred over a traditional antler tine pressure flaker because it produced sharper, more effective, and more regularized functional edges, and it also reduced the likelihood of breaking the tools during manufacture.

The overall formal characteristics of the ten experimental tools (Figure 41) lie within the range of morphological variation exhibited by the prehistoric study sample specimens (Chapter 2.2; Appendix 3; Table 1; Figures 11 to 20). Consequently, it was reasoned that all were capable of performing activities related to the primary function of prehistoric key-shaped formed unifaces.

Four of the replicated experimental tools had pronounced bulbs of percussion and/or large initiation facets (striking platforms). These were removed using either direct freehand hard hammer percussion or pressure flaking. This permitted the tool butts to be more easily fitted into haft slots (see below and Figure 10). Similar basal thinning was noted on the prehistoric specimens, and presumably it was executed for the same reason. Removal of sharp edges and ridges associated with the flake blank initiation facet also rendered the tool more comfortable for manual (i.e., hand-held) use.

Nine experimental tools were hafted into wooden handles made from sections of green saskatoon stalks measuring about 10 to 15 cm long and 2 to 3 cm in diameter (Figures 10 and 42). The proximal end of each tool was snugly inserted into a slot cut into one end of the haft, bound tightly with raw buckskin or common household cotton string, and cemented firmly into place by dripping melted ponderosa pine *(Pinus ponderosa)* pitch over the binding (Figure 10). Pitch was commonly used as a glue and mastic by ethnographic inhabitants of the Plateau (Teit 1900:241; Ray 1933:61,89).

E.T.'s #1, #4, and #6 to #10 were hafted prior to being used. E.T.'s #2, #3 and #10 were initially used hand-held (i.e., unhafted), but they were all eventually hafted at some point early in their use-histories (see Chapter 7.6 and Appendix 9). Only one tool (E.T. #5) was used unhafted for its entire use-history.

After being manufactured, the experimental tools were placed in plastic bags to protect their edges from incidental traumatic contact with hard objects during storage and transport. This ensured that accidental damage would not be incurred to margin edges that might later be construed as being a result of use.

Prior to using the experimental tools, their distal projection tips, concave and "opposite" margins, and ventral faces were photographed at 6.4 X magnification using a Wild M3 stereoscopic light microscope's built-in camera. These photomicrographs were later compared to similar photos taken of the same features after tool-use to help identify and describe the nature and intensity of microwear trace patterns incurred (Chapter 8; Figures 54 to 65).

### 7.4 Experimental Contact Materials

Three types of contact materials were worked. They included the main stalks and primary branches of three types of fresh "green" woody plants, two dense mule deer antler beams, and a metacarpal from a mule deer foreleg.

It was surmised that if the primary function of prehistorically-used key-shaped formed unifaces involved working of woody plant parts, the most probable candidates would have been the main stalk (trunk) of small saplings, the primary branches of woody shrubs or trees, and perhaps tree roots. This was inferred by the fact that their diameters often range between about 5 and 30 mm, and they are relatively hard and rigid. It was also assumed that in prehistoric times, bark and wood would have been most often worked when fresh or "green", as other experimental studies have indicated that they are significantly more difficult to work when seasoned (dry) (see Keeley 1980:36; Vaughan 1985:34; Richards 1987:156).

Three types of woody plants were selected for the experiments: saskatoon *(Amelancheir alniffolia)*; Rocky Mountain juniper *(Juniperus scopulorum)*; and

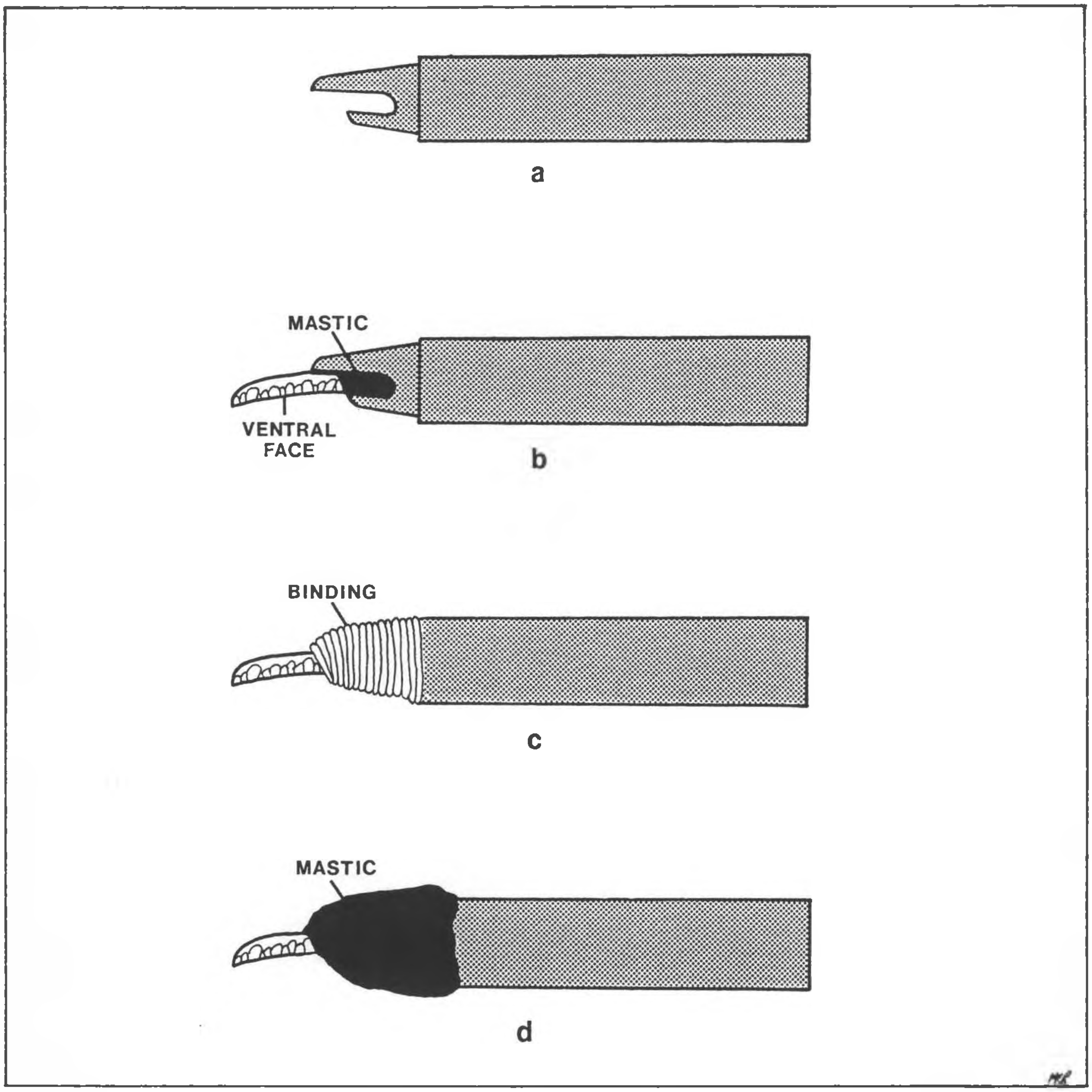


**Figure 10.** Hafting strategy used for nine of the ten experimental tools used in this study (side view).

(a): Handle about 2-3 cm diameter made from green saskatoon wood with one end slotted and modified;

(b): Key-shaped formed uniface was inserted and secured with ponderosa pine pitch;

(c): Binding, consisting of either leather strips or cotton cord, was wrapped tightly around the handle/tool juncture; and

(d): Mastic was applied, moulded in place by hand, and allowed to harden.

willow *(Salix* sp.). All were commonly used by inhabitants of the Plateau during the enthographic period, and are relatively abundant and ubiquitous in the Pacific Northwest today (Turner 1979:72,230,258).

Saskatoon or "service berry" wood was very important for making arrows, and for manufacturing digging stick shafts, spear and harpoon shafts, implement handles, fire drills, basket frames, and canoe frames (Teit 1900:205, 231,235,241; 1909:514,519; Turner 1979:27, 230-232).

Rocky Mountain juniper wood was used primarily to make bows, and occasionally snowshoe frames and spears. Juniper bark was used to make baskets (Teit 1900:239; 1909:519; Turner 1979:71-73).

Willow stalks and branches were employed to make fish traps and weirs, net hoops, firedrills, and tinder. Stripped and/or shredded willow bark was often used for clothing, nets, bags, basketry, cordage, diapers, wound dressings, and sanitary napkins (Teit 1909:527; Ray 1933: 62-63,67-68; Turner 1979:260-261). Detailed descriptions and additional information for the three woody plant types used in the experiments are presented in Appendix 8.

Six experimental tools (E.T.'s #1, #3, #5, #6, #8, and #10) were used on fresh green saskatoon stalks and branches; E.T. #2 was used on green juniper branches; and E.T. #4 was engaged to work green willow stalks and branches (Appendix 9). In addition, E.T. #3 was resharpened after being used on green saskatoon, and subsequently employed to briefly work seasoned saskatoon.

Green saskatoon was used most frequently in the experimental component of this study because: (1) it is readily available in most all areas of the Plateau today, and there is no reason to suspect that it would have been any less abundant or ubiquitous during the late prehistoric period; (2) ethnographic accounts indicate that it was used to manufacture several important and commonly-used artifacts and implements having moderate to high production and/or replacement rates (e.g., projectile shafts, handles, basketry); (3) its bark cannot be easily peeled off by hand, and debarking is most effectively accomplished with a sharp-edged stone tool (see Chapter 7.6.1 and Appendix 9); and (4) it was reasoned that by using several experimental key-shaped formed unifaces made of different lithic raw material types on this contact material, observed variation in resulting microwear would be primarily attributable to differences in the physical characteristics of the lithic raw materials, and to variation in motor patterns employed by individual experimenters.

Prior to working main stalks and larger primary branches of the green woody plants, their small secondary branches having diameters less than about .75 cm were usually removed manually. This involved pulling them forcefully toward the butt of the primary stalk/branch, thereby tearing them away at their "node" (i.e., juncture with the main stalk/branch). On a few occasions, these secondary branches were cut off with a steel knife so that a .5 to 1 cm-long "stub" was left attached on the nodes. These stubs and nodes were subsequently removed with the experimental tools (see below).

Seasoned (dry) saskatoon was also worked briefly to resolve whether it truly is more difficult to work than green saskatoon, and to determine if the microwear traces incurred would differ significantly from those developed on tools used to work the green woody plants.

A dense, relatively fresh, main beam of a mule deer *(Odocoileus hemionus)* antler was soaked in water for one month, as Teit (1909:474-475) indicates that the ethnographic Shuswap commonly immersed antler and bone in water for several days to soften them before being worked. A second dense mule deer antler beam was boiled in water for eight hours to see whether this rendered it any easier to work than the soaked antler.

The metacarpal longbone from the lower right foreleg of a mature mule deer killed in the fall of 1987 was defleshed, and also soaked in water for one month. The foreleg had been previously frozen, but it is unlikely that this would have had any significant effect on the outcome of the experiments. Both deer bone and antler were employed by prehistoric inhabitants of the Plateau to make a wide variety of implements. E.T. #7 was used to work both the bone shaft and two antler beams, whereas E.T. #9 was employed on the soaked antler beam only.

## 7.5 Experimental Conditions and Data Recording

Experiments were undertaken in both natural and laboratory contexts. Those involving green woody plants were conducted in outdoor settings at three locations: (1) the Keatley Creek archaeological site located ca. 7 km south of the community of Pavilion, B.C. in the Mid-Fraser River region; (2) the B.C. Ministry of Forestry campground at Three Sisters Creek ca. 20 km southwest of Ashcroft, B.C.; and (3) in a rural backyard setting beside the Fraser River in Delta, B.C..

There was a considerable quantity of sand, silt, dust, and grit present in the local working environment at Keatley Creek, where constant and intense pedestrian traffic within a camp kitchen area had significantly denuded local grassy vegetation. Airborne abrasive particles were commonly observed on gusty days, and these sometimes adhered to freshly exposed damp bark and wood. Sand and silt also occasionally clung to damp bark and wood when a stalk/branch was rested on unvegetated working areas between use-episodes. Very few abrasive particles were present in the immediate working environments at Three Sisters Creek campground and the residential backyard on River Road due to dense grassy vegetation cover.

Experimental tool-use on woody plants was conducted by the author and four volunteers. They included John Breffitt, Gyles Iannone, Peter Merchant, and Bob Muir. All experimenters used the tools with their right hands, and stalks and branches were held in their left hands (e.g., Figures 43, 44, and 47 to 49). Experimenters sat on the ground and/or on rocks and logs in all three use contexts to imitate prehistoric working conditions.

Experiments involving the mule deer metacarpal and antler beams were conducted by the author at Simon Fraser University in the Department of Archaeology's flintknapping pit. These contact materials were rested on a large anvil boulder located in the center of the flaking pit (Figures 50 and 51). The surface of this boulder contained a moderate amount of sand, silt, and dust which occasionally adhered to the wet bone and antler when they were rested upon it.

During the experiments, all information considered to be important or pertinent to the research problem was recorded on a prepared form. Each experimenter was responsible for documenting the following information for each tool: (1) the total number of working strokes used; (2) the average working stroke length in centimeters; (3) the approximate total use-time elapsed; (4) the approximate length and average diameter of stalks/branches processed; and (5) noting when and where significant microwear trace types could be observed with the unaided eye on tool edges or surfaces during use.

Subjective assessments concerning the suitability and relative functional efficiency of specific parts of the tools for performing certain tasks were advanced, as were details about the specific motor patterns employed. Results of these observations are summarized in Chapter 7.6 and Appendix 9.

At various experimental stages, photographs were taken using both black-and-white and colour slide film. When stored or being transported, the experimental tools were placed in plastic bags to protect their edges from coming into incidental forceful traumatic contact with hard objects. This ensured that *all* microwear traces incurred on the working edges of the experimental tools could be attributed entirely to factors related to their use-episodes or manufacture.

Following the experiments, all tools were removed from their hafts, and gently cleaned with acetone and a very dilute solution of "Pine Sol" cleanser to remove ponderosa pine pitch hafting mastic, and residues contributed by the contact materials. The main functional edges and ventral faces were re-photographed at 6.4 X and 18 X magnifications (Figures 54 to 65) using the built-in camera on a Wild M3 light microscope. The resulting photographs were compared to those taken prior to the experiments to determine the nature and extent of the microwear traces incurred.

## 7.6 Experimental Methods and Observations

Eight of the ten experimental tools were engaged in working stalks and branches of fresh green woody plants with diameters ranging between ca. .3 and 2.5 cm. Experimental tools (E.T.) #1, #3, #5, #6, #8 and #10 were used on green saskatoon; E.T. #2 was used on green juniper; and E.T. #4 was used on green willow. After being used on green saskatoon, E.T. #3's concave margin was retouched and subsequently used to briefly work seasoned saskatoon. One tool, (E.T. #7) was used to work soaked and boiled antler beams, and E.T. #10 was used to scrape and shave the soaked antler beam only. Details regarding experimental use-histories of these tools are presented below and summarized in Appendix 9.

Six tools (E.T.'s #1, #5 to #7, #9 and #10), were used until the experimenters felt that their concave margins required resharpening in order to restore their initial and/or optimal functional efficiency. However, the use-life potentials of the concave margins for the remaining four tools (E.T.'s #2 to #4 and #8) were not fully realized. Nevertheless, they were all used for many thousands of strokes over considerable periods of time, and plainly indicated very extensive use-life potential.

### 7.6.1 Bark Stripping and Woodworking

**Hafting Efficiency**

During woodworking experiments, one tool (E.T. #5) was used unhafted throughout its entire use-history. Another three tools (E.T.'s #2, #3 and #10) were also intitially used unhafted. This was done purposefully to assess the relative functional efficiency of unhafted tools for performing the tasks undertaken.

All five experimenters agreed that unhafted tools functioned reasonably well for bark stripping and woodworking activities. However, after about 3000 to 4000 strokes of continued use applying moderate to heavy pressure, several experimenters noted that their hands became cramped, and occasionally small cuts and abrasions developed on the right thumb and index finger where they contacted sharp edges and flake ridges. It was also noted that it was difficult to fully realize and assess the maximum functional efficiency of the "opposite" margin when using a hand-held tool because the heavy pressure needed to attain it could not be applied comfortably for very long.

Prior to being used, several tools (E.T.'s #1, #4, #6, #8 and #10) were hafted into short thick sections of saskatoon stalks measuring ca. 10 to 15 cm long by ca. 2 to 3 cm in diameter. All five experimenters unanimously agreed that hafted tools were functionally superior to hand-held ones because they: (1) afforded greater levels of mechanical and functional efficiency; (2) improved manipulation and significantly enhanced the ability to comfortably apply heavy pressure; (3) markedly reduced and/or eliminated the incidence of hand muscle cramping during extended periods of use; and (4) did not invoke any trauma to the thumb and forefinger because the incidence of manual contact with sharp edges and ridges was greatly reduced.

The hafting strategy employed during the experiments lent an important and unpredicted element of mechanical efficiency to the design and use of the tool. The juncture of the binding/mastic and the ventral face of the tool (Figure 10) functioned as a very effective "guide", allowing the tool to be accurately and rapidly drawn along the stalks/branches (see Figures 43 and 47). Because of the overwhelming functional advantages afforded by hafting, four of the initially unhafted tools (E.T.'s #2, #3, #6 and #10) were secured in saskatoon hafts at some early point in their use-histories (Appendix 9).

Generally, the ponderosa pine pitch mastic functioned very well for keeping the tools secure in their hafts, but it was noted to be somewhat sensitive to ambient temperatures. When left directly in the sun it became soft and tacky, and when the tool was used in this condition it sometimes loosened a bit in the haft, and pitch often stuck to the fingers. Between 10° and 30° C in the shade, the pitch mastic was fairly hard and held the tool firmly in place even under heavy pressure loads. Below about 10° C the mastic became quite brittle and prone to cracking. Only two experimental tools required haft repairs because of mastic cracking, and both cases occurred on fairly cool evenings. They were simply and quickly restored by retightening the binding and reapplying melted pitch.

## Contact Material Positioning

During the experiments, stalks and branches of the woody plants were held in several ways. In most instances they were oriented more or less perpendicularly to the transverse plane of the body (i.e., pointing away), at a horizontal or slightly inclined position (Figures 43 to 49). Usually, one end of the stalk/branch was steadied by bracing it against the body with the left arm. The left hand was most always placed above (i.e., distally) the section of the stalk/branch being worked when using the concave margin, but when engaging the "opposite" margin or distal tip the hand grasped below the section being worked.

Occasionally the proximal end or "butt" of a stalk/branch was placed perpendicularly on the ground surface and braced with the soles of both feet. Removal of bark and wood was then assumed using the concave margin in downward vertical strokes. Rarely, the distal end of a long (greater than 1.5 m) stalk or branch was steadied by placing it between the soles of both feet, or between the big toe and second toe of either foot while in a sitting position on the ground.

## Distal Projection Motor Patterns and Efficiency

The distal projection was employed for two main tasks during woodworking. The foremost of these was removal of bark and wood comprising the secondary branch nodes in order to regularize and smooth the objective primary stalks and branches. For this task, the dominant motor pattern involved grasping the haft, placing the index finger on the dorsal surface of the distal projection, and using the distal edge and ventral-lateral corners of the distal projection tip with moderate to heavy levels of applied pressure to repeatedly gouge, pry, scrape, and shave the bark and wood away from the nodes (Figure 9a and 9b). Sometimes, the distal edge of the projection was used in a lateral side-to-side "sawing" motion to help remove the central woody portions of the nodes (Figure 9c). The distal projection tip was considered to be quite effective for removing secondary branch nodes using these techniques.

A second important and highly effective capability of the distal projection tip was incising and engraving linear grooves into stalks and branches. This entailed grasping the tool in the same manner described above, placing the distal edge or a ventral-lateral corner of the projection tip against the wood so that the ventral face of the tool inclined proximally between about 30° and 60°, and then using very heavy pressure to engrave/incise linear scores or grooves using a repeated "back-and-forth" motion (Figure 48).

The width of the incisions and grooves depended on which parts of the distal tip were used. The ventral-lateral corners of the distal projection were used to initiate narrow incisions, and for starting larger grooves. Once an incision was sufficiently widened with the ventral-lateral corners, the distal edge of the tip could be inserted to widen it further and create substantial grooves. Groove/incision depths depended on how long a tool was used, and the amount of force being applied.

## Concave Margin Motor Patterns and Efficiency

For all experimental tools engaged in woodworking, the concave margin edge was the most commonly used and most functionally effective feature. The primary motor pattern associated with the concave margin for hafted tools involved: (1) grasping the haft and placing either the index finger or thumb on the medial aspect of the "opposite" margin's dorsal face; (2) placing the ventral face of the distal projection against the stalk/branch with the concave margin facing the user's body, and the projection tip pointed away at a slightly oblique angle; and (3) drawing the tool toward the body using moderate to heavy pressure in repeated strokes varying between 5 and 20 cm long (Figures 43, 44 and 46). The heavy force loads required to remove thick bark and secondary branch nodes, and to significantly modify (i.e., "carve") wood were easily and comfortably applied using the hafted tools in this manner.

When working branches with diameters less than about .5 cm, the thumb of the right hand was sometimes used to brace and support them against the ventral face of the tool. This was found to be particularly useful for working small willow branches, which are typically quite pliable.

When used unhafted, the concave margins of the experimental tools were used in generally the same manner as for hafted tools. The proximal portion of unhafted tools was gripped between the thumb and third finger of the hand of preference, and the index finger was placed on the medial aspect of the "opposite" margin's dorsal surface. Moderate to heavy force loads were then applied to remove bark and/or work wood. Heavy force loads were usually required to remove secondary branch nodes or thick bark and to work wood. For these situations, force loading and mechanical efficiency were slightly enhanced by holding the proximal portion of the tool between the thumb and third finger of the hand of preference and placing the thumb of the other hand on the dorsal surface of the "opposite" margin (Figure 46).

The experiments demonstrated that the concave margins of the tools functioned effectively for swift mechanical removal of bark from all three types of green wood in long (5-20 cm), narrow (ca. 3 mm), fibrous strips (Figure 52). However, it was noted that juniper and willow bark could be more easily and quickly removed by simply peeling off large strips and sections by hand. Conversely, saskatoon bark could not be manually peeled from its wood very well at all, rather, it came off in small patchy pieces, and took considerable time to remove in this manner. Heating and scorching green saskatoon branches for several minutes in a bed of campfire coals significantly improved the ability to remove the bark manually. However, once the branch cooled the bark again became difficult to peel off. Removal of saskatoon bark by scorching required several reheatings of the branch, and the resulting soot made it a rather messy task. Removal of green saskatoon bark using the concave and "opposite" margins of the experimental tools was just as effective, much cleaner, and required slightly less time.

The concave margin was also considered to be very effective for shaving, scraping, and planing down the "green" woody portions of stalks and branches of all three types of tree plants used in the experiments. It worked well for regularizing and smoothing primary stalks and branches, such as are required to make atlatls and bows, and shafts for spears, atlatl darts, arrows, etc. It also functioned moderately well for removing woody portions associated with secondary branch nodes using short scraping and planing strokes (although the distal projection tip was more efficient for this purpose), and for significantly altering (carving) green wood.

During use on green woody plants, the concave margin often clogged up with accumulations of plant resins and small bark and wood fibres. These "wads" of matted sticky fibres commonly invoked temporary loss of tool efficiency by coming between the concave margin edge and the bark/wood being worked. The wads were easily removed with a downward flick of the thumb, thereby restoring edge efficiency. It was usual to have to flick them off about every 5 to 10 strokes when working saskatoon, and about every 15 to 20 strokes for juniper and willow.

After being used on green saskatoon, the concave margin of E.T. #3 was resharpened and briefly used on seasoned saskatoon for about 1000 strokes (Appendix 9). This was done to assess how much more difficult dried saskatoon was to work than when it was green, and to determine whether microwear traces resulting from working these two materials would differ in any significant manner. A great deal of effort and pressure was required to remove the bark, and it was extremely difficult to modify the wood in any manner. It was also noted that the tool edge dulled quite rapidly (after 1000 strokes), and at least two large microflakes were removed from the ventral edge aspect. As predicted, seasoned saskatoon is definitely far more difficult to work than green saskatoon, and this is probably true for most all other woody plant types.

### "Opposite" Margin Motor Patterns and Efficiency

The "opposite" margins of the experimental tools were used much less frequently than the concave margins during woodworking activities. It was most often used to strip bark and/or to shave and plane down wood at the ends of stalks or branches. The primary use-pattern for hafted tools entailed: (1) grasping the haft and placing the thumb on the medial aspect of the concave margin's dorsal surface; (2) placing the ventral face of the tool against the stalk/branch so that the "opposite" margin edge was perpendicular or slightly oblique to the long axis of the stalk/branch; and (3) pushing the tool away from the body using moderate to heavy pressure to strip bark and/or to shave, scrape, and plane down green wood in repeated "whittling" strokes varying between about 5 and 15 cm in length (see Figure 47).

The experimenters noted that while working green wood with the "opposite" margin in this "whittling" fashion it functioned rather effectively, but often there was a tendency for the tool to "chatter" one to three times during an average stroke. This produced transverse or slighly oblique linear gouges or "chattermarks" that snagged the working edge and intensified the chattering effect. This was particularly common problem when working stalks/branches greater than 1 cm in diameter. Chattering commonly interupted attempts to maintain a steady cadence to the working strokes, and was thus viewed to be both a nuisance and functional liability.

The "opposite" margin also functioned reasonably well for removing bark and woody portions associated with secondary branch nodes. This technique involved placing both thumbs on the dorsal aspect of the concave margin to exert the heavy force loads required to shave, gouge, and/or "pry" them off using very short strokes between about .5 and 1 cm long (Figure 45).

In general, the "opposite" margin was a bit more mechanically awkward to use than the concave margin for bark stripping and woodworking, and the associated working strokes tended to be shorter and were more prone to being disrupted by chattering. It was primarily for these reasons that the concave margin was preferred over the "opposite" margin for executing most bark and woodworking tasks.

Again, matted wads of sticky plant resins and bark and wood fibres sometimes adhered to the dorsal and ventral surfaces of the "opposite" margin, clogging its working edge. As with the concave margin, these wads were quite easily flicked off using the index finger, thereby restoring edge efficiency.

### Lithic Raw Material Efficiency

The experiments indicated that tool efficiency and longevity varied between lithic raw material types used to make the experimental tools employed in bark removal and woodworking. This assessment is based on a collective consideration of the total number of working strokes, time elapsed, and relative degree and intensity of wear incurred by each of the different lithic materials employed (Appendices 7 and 9; Tables 6, 9 and 10).

The experimental data suggest that the most durable lithic material is Type 2 chalcedony from southern Washington, which was used to work green juniper and saskatoon. It demonstrated a long use-life and a high resistance to edge dulling. Its high level of efficiency and longevity are attributed directly to its hardness and toughness, as it has a Moh hardness value of about 8.0 (Appendix 7). High density and resiliency were also noted when it was being flaked.

The next most durable lithic materials are Type 1 chert from northern Oregon, and Type 5 chalcedony from Upper Hat Creek (Appendix 7). They too indicate relatively long use-life potential which can be directly attributed to their hardness (Moh value = 8.0), high density, and superior toughness and resiliency.

Type 3 chert was considered to be a very poor lithic material for working bark and wood. It indicated a rapid rate of acute edge deterioration and dulling manifest by intensive and extensive microflake removal and crushing. These were particularly accelerated when attempting to remove bark and wood associated with secondary branch nodes. The poor functional efficiency associated with this lithic type was not surprising, since its Moh hardness value is only 6.5, and it was noted to be quite brittle when being flaked.

The relatively short use-life (ca. 5250 strokes) of the concave margin of E.T. #6, made of Type 4 chalcedony, was surprising. Since it has a Moh hardness value of about 7.5, it was expected to have a use-life nearly as comparable as tools made of Type 1 chert, and Type 2 and Type 5 chalcedonies with Moh hardness values of 8.0. I postulate that the relatively rapid dulling rate of the concave margin on E.T. #6 may be partly due to idiosyncratic experimenter motor patterns, as the tool was used fairly aggressively (i.e., quickly and with very heavy pressure), and the ventral face of the tool was often held at a relatively steep angle (i.e., greater than 45°) relative to the wood (see Appendix 9). Edge dulling may have particularly accelerated when secondary branch nodes were being removed in this manner.

Alternately, it may be that translucent chalcedonies (such as Type 4 chalcedony) are less durable than are other types of chromatic chalcedonies, and some cherts. Translucent chalcedonies consist primarily of pure colloidal silica or "silica gel" and occasionally include some crystalline silica, and very few mineral or organic (fossiliferous) impurities. Although they too are comprised mostly of colloidal and crystalline silica, chromatic chalcedonies and all cherts also contain varying amounts of other minerals and/or organic impurities that impart their colour and opaqueness. It may be that chromatic chalcedonies and some cherts are more durable than translucent chalcedonies because their included minerals and other impurities serve to strengthen inter-molecular and/or inter-granular bonds. Regrettably, the scope of the present study does not allow this possibility to be examined.

E.T. #10 is made of Type 6 vitreous basalt, and in the initial part of its use-history, the concave margin of the tool functioned quite well for bark stripping and woodworking. However, continuous pronounced microflake removal, rounding, and crushing along the concave margin edge rendered it dull after about 6000 strokes (Appendix 9). This was not surprising, since this material has a Moh hardness value of only 6.5, and it was noted to be quite brittle when it was flaked -- a suspected result of its microcrystalline groundmass.

### 7.6.2 Results of Working Deer Antler

Experimental tools #7 and #9 were used to work two dense antler beams. One beam was from a mature mule deer, and measured approximately 25 cm long by 3 cm in diameter. It was soaked in water for one month prior to being worked. The second beam was from a two-year old mule deer and measured about 15 cm long by 2 cm in diameter. It was boiled in water for eight hours before being worked (Appendix 9).

E.T. #7 was made from Type 5 chalcedony, and was used to scrape and shave the soaked antler beam. Most of the experimental and microwear data mentioned for antler in this section, and in Chapter 8, are related to working the soaked beam with this tool. After being used on the soaked antler, the concave margin of E.T. #7 was resharpened and used very briefly on the boiled beam simply to determine whether boiling increased the workability of antler in any manner. E.T. #9 (Type 6 fine-grained basalt) was used only on the soaked beam (Appendices 7 and 9).

#### Hafting Efficiency

Both tools engaged in working antler were hafted prior to use. As was observed during woodworking, hafting served to markedly reduce muscular stress in the hand, allowed effective tool manipulation, and permitted heavy levels of pressure to be applied with relative ease.

Even though E.T. #7 was hafted securely following the same procedure used to haft the woodworking tools, it became quite loose after about 1200 strokes on the soaked beam. Very heavy pressure loads were required to effectively work this contact material, consequently, great stress was directed through, and absorbed by, the juncture of the tool and its haft. E.T. #9 remained rigid in its haft for the duration of it's short use-life.

#### Contact Material Positioning

The soaked antler was held in two basic positions while being shaved and scraped with the concave margin. The first involved resting one end of the beam on a large anvil boulder and holding the "opposite" end with the left hand so that its shaft was either oriented vertically or slightly inclined (e.g., Figure 51). For this method, stroke direction was from top to bottom. The second technique involved simply resting the beam horizontally on a boulder anvil with the shaft oriented perpendicular to the transverse plane of the body, and strokes were initiated in a distal-to-proximal direction. The beam was placed horizontally on the boulder when incising or engraving (Figure 50).

### Distal Projection Motor Patterns and Efficiency

The distal projection tip was used to incise longitudinal linear grooves into the soaked antler beam following the "groove and splinter" technique used to manufacture elongate antler tool blanks. This was accomplished by: firmly grasping the tool haft and putting the index finger on the dorsal surface of the distal projection; placing either the distal edge or one of the ventral-lateral corners of the projection tip against the antler so that the tool was inclined at about a 45° angle relative to the beam; and pushing the tool back-and-forth with considerable pressure in repeated strokes measuring about 10 to 15 cm long (see Figures 9d and 50). As was the case for stalks and branches of green woody plants, incision/groove widths could be controlled by using different parts of the distal tip edges and/or by altering the working angle of the tool. Groove depth depended on the pressure exerted and amount of working time elapsed.

The distal projection tip functioned moderately well for incising and engraving linear scores and grooves into the antler beam parallel to its longitudinal axis, but it was much more awkward for incising lines accross the beam because of its roundness. The upper 1 to 2 mm of outer antler cortex softened by soaking was removed with moderate ease, and produced antler shavings measuring between 1 and 4 cm long, and about 1 to 5 mm wide. Incising/engraving became much more difficult and significantly less effective once the softened cortex had been penetrated.

### Concave Margin Motor Patterns and Efficiency

The concave margins on both experimental tools were used to scrape and shave down the main "shaft" portion of the soaked antler beam by: firmly grasping the tool haft and placing the thumb on the medial aspect of the distal projections's dorsal surface; placing the ventral surface of the distal projection against the beam so that the projection tip was oriented away from the user at a slightly oblique angle; and drawing the tool toward the user using very heavy levels of applied pressure in repeated strokes about 10 cm long.

During initial use on both the soaked and boiled antler beams, the concave margin of E.T. #7 was sharp, and it was considered to function reasonably well for shaving and scraping down the outer 1 to 2 mm of their softened cortex. This was also observed for E.T. #9, which was used on the soaked antler only. Small shavings ranging between about .5 and 4 cm long, and about 2 to 3 mm wide were removed (Figure 53). However, once the softened outer 1 to 2 mm of the antler beams had been penetrated, the shavings were significantly smaller and much more difficult to remove.

The functional efficiency associated with scraping and shaving the soaked antler beam with the concave margin edge was about the same as that noted for the boiled antler beam. Therefore, it was concluded that boiling does not render antler significantly easier to work than soaking it, at least as far as using key-shaped formed unifaces is concerned.

When compared to the use-lives of experimental tools used for woodworking, both tools used on antler dulled much more rapidly. This is attributed to the obvious superior hardness of antler compared to the three types of green woody plants, and to the greater levels of applied force required to work it.

**"Opposite" Margin Motor Patterns and Efficiency**

The "opposite" margin of E.T. #9 was very rarely used to scrape and shave the soaked antler beam. When used, it involved grasping the haft and putting the thumb on the dorsal surface of the concave margin, placing the ventral face of the tool on the antler shaft so that the "opposite" margin edge was roughly perpendicular to the long axis of the beam, and pushing the tool away from the body in a shaving and scraping "whittling" motion. The "opposite" margin of E.T. #7 was not used to work antler.

It was concluded that shaving and planing of the soaked antler beam with the "opposite" margin was not a very successful endeavour. The concave margin was considered to be much easier to manipulate, and functioned far more efficiently for this task.

**Lithic Raw Material Efficiency**

The two lithic raw material types employed to work antler performed quite differently with regard to functional efficiency and use-life potential (Appendix 9). The concave margin edge of E.T. #7, made from type 5 chalcedony, required resharpening after about 1,700 strokes on soaked antler, and after resharpening, it became noticably dull after about 250 strokes on the boiled antler. E.T. #9's edge (Type 6 fine-grained basalt) lasted only 400 strokes on soaked antler. This clearly indicates that chalcedony is far more durable than basalt for working antler, a pattern that was also observed during the woodworking experiments. Again, the inferior hardness and greater brittleness of microcrystalline basalt is blamed. Heavy loads of applied force required to scrape, shave, and groove antler quickly dulled the working edge of the basalt tool by invoking pronounced crushing and extensive microflake removal along both ventral and dorsal edges.

### 7.6.3 Results of Working Deer Bone

Experimental Tool #7 (lithic Type 5) was initially used to attempt to scrape a longbone (metacarpal) from the foreleg of an adult mule deer. The bone measured ca. 20 cm long by 2.25 cm diameter, and had been soaked in water for one month (Chapter 7.4; Figure 51). The tool was used initially to work the deer bone for 500 strokes, and was subsequently used on soaked antler (see above).

**Motor Patterns and Functional Efficiency**

Use of a hafted tool was considered to be highly effective for working either soaked (or unsoaked) bone because it enabled heavy pressure to be applied that could not otherwise be exerted using an unhafted tool.

The bone was held using the same two basic methods described above for the antler beam. The first of these involved placing one end on a large boulder and holding the opposite end so that the shaft was either vertical, or slightly inclined (Figure 51). The concave margin was used for scraping and shaving, and stroke direction was from top to bottom. The second method involved resting the bone horizontally on a boulder with the shaft oriented perpendicular to the lateral plane of the body, and scraping and shaving was executed in a distal-to-proximal direction.

A brief attempt was made to incise a linear groove along the longitudinal axis of the bone using the distal projection tip following the procedure and motor patterns described above for grooving antler. This task was associated with a low level of success and efficiency because the bone was very difficult to penetrate, and the tip of the tool repeatedly slipped off (see also Lynott 1975). Nevertheless, a small incision was created with one of the projection's ventral-lateral corners, but not without considerable effort.

The concave margin on E.T. #7 was used to try to scrape and shave down the shaft of the soaked metacarpal using the same technique described above for scraping and shaving the soaked antler shaft. Attempting to work soaked bone in this manner was associated with a very low level of success. Despite the tool's sharp edge and use of heavy pressure, it only succeeded in scratching or slightly smoothing the surface of the bone, or occasionally removing minute shavings measuring about 2 to 5 mm long by about .5 mm wide. Soaking the bone for one month did not appear to have softened it significantly. Not surprisingly, the concave margin functioned well for removing residual soft tissue. The "opposite" margin was not used to work bone, as it was plainly evident that there was no task that this margin could have been used for that the concave margin could not have accomplished as well or better.

## 7.7 Summary and Discussion of Experimental Results

### Bark and Wood Working

The experimental results indicate that key-shaped formed unifaces functioned quite successfully and effectively for stripping bark and shaving, scraping, and planing down stalks and branches of all three types of green woody plants worked. For all eight tools, the concave margin edge was used most frequently for these tasks, and consequently it was always the first edge to become dull. The "opposite" margin was used much less frequently, and was usually engaged for removing bark and wood from the ends of stalks/branches, and from secondary branch nodes. The distal tip was very effective for removing secondary branch nodes, and for incising and engraving linear scores and grooves of various widths and depths.

There was unanimous consensus among the experimenters that hafted tools were more efficient and easier to use than hand-held tools. Hafting significantly enhanced tool comfort, manipulability, and effectiveness, and allowed much greater loads of force to be applied. During the experiments, either the thumb or forefinger was commonly placed on the dorsal surface of the distal projection. This increased the amount of force that could be applied to, and/or be absorbed by, the tool. It also helped to relieve stress that would otherwise be directed into, and completely absorbed by, the hafting joint which could result in loosening a tool from its handle.

Overall, the concave margins of E.T.'s #1 and #2 (Type 1 chert), E.T.'s #3 and #4 (Type 2 chalcedony), and E.T. #8 (Type 5 chalcedony) all indicated fairly long use-lives before requiring resharpening. In contrast, E.T. #5 (Type 3 chert), E.T. #6 (Type 4 chalcedony) and E.T. #10 (Type 6 basalt) dulled much more quickly. This lends strong support to the hypothesis that chalcedonies and some cherts are more durable than other types of cherts and basalts, and this was the primary reason that they were purposefully selected for production of prehistoric key-shaped formed unifaces. From this it can be inferred that these tools were intended to be used most often on relatively hard contact materials (Chapter 3.3.3), and that functional longevity was also deemed to be an important feature of this tool type.

Because juniper and willow bark were more quickly and effectively removed by hand than with the experimental tools, I suggest that the prehistoric incidence of using these tools to remove bark from these woody plants -- and others with bark like them -- would have been low. Saskatoon bark could not be removed very easily by hand, but it could be swiftly and efficiently removed using the concave or "opposite" margin edges.

Bark strips and shavings produced as a by-product of working green saskatoon bark and wood are fibrous, strong, very flexible, and can sometimes be quite long (Figures 43 and 52). Freshly stripped saskatoon bark and wood have a pungent but pleasant almond-like fragrance. When dry, a subtle hint of this odor is retained. Dried shreddings are absorbant, relatively soft, and very supportive when densely packed. It is conceivable that they may have occasionally been used for bedding. Dried bark and wood strips were also determined to be effective tinder (i.e., it combusted easily and quickly) for starting fires. Twisted strands of fibres about 3 to 5 mm in diameter were braid-woven to make a strong piece of cordage about 15 cm long and 8-10 mm wide, and it is possible that similar cordage or rope was made in prehistoric times. Unfortunately there are no ethnographic or archaeological data to support any of these postulated potential uses for saskatoon bark and wood shreddings.

While working green bark and wood, it was noted that the incidence of microflake scar formation increased significantly along edges when removing and smoothing down secondary branch nodes. This phenomenon has been documented previously during other woodworking experiments (Odell 1981b:202). It was also observed that polish developed more rapidly when working woody parts of green stalks and branches compared to removing the bark only.

Although it was noted that the distal tips of many (45.7%) items in the study sample of prehistoric key-shaped formed unifaces had been removed by either flexure (34.3%) or torsion (11.4%) fractures, no such breakage occurred during the experiments. Nevertheless, a consideration of the experimental results indicate that at least four possible explanations can be advanced to account for this phenomenon. First, a small portion (e.g., the distal 1/4) of a projection tip may have been intentionally removed by flexure breaks by direct freehand hard hammer retouch to rejuvenate worn ventral-lateral corners and distal edge. Second, larger portions (e.g., more than 1/3) of the projection may have been accidentally removed by such fractures while the concave margin or distal projection tip were being resharpened or rejuvenated. Third, flexure or torsion fractures might have been initated when heavy pressure was being applied to the projection during use -- especially during incising and graving actions. Lastly, flexure fracturing could have possibly resulted when excessive force was exerted by either the thumb or forefinger on the dorsal surface of the distal projection when it was engaged in rigorous scraping, planing, shaving actions, causing the distal 1/2 to 1/4 of the projection to snap in a ventral direction.

In the latter two scenerios, trauma to the thumb or forefinger would have been very probable, resulting in cuts and/or abrasions. In such cases, human blood may have been deposited on the tool surface. The strong positive reaction results obtained for blood (haemoglobin) on specimen FiRs 1:5699 from Punchaw Lake (Table 3; Figure 11k) may be owing to this agency.

Extended use of hand-held key-shaped formed unifaces could also possibly result in transfer of small quantities of human blood to the surface of a tool originating from cuts and/or abrasions on the thumb and fingers caused by prolonged forceful contact with sharp margin edges and flake ridges. Also, during the woodworking experiments, the tools sometimes slipped off the stalks/branches when heavy pressure was being applied, and occasionally the tip of the distal projection would accidentally slash or gouge the anterior part of an experimenter's left forearm, or more rarely, left thigh or calf.

Therefore, it is quite possible for human blood residues to be transfered to the surfaces of these tools during use (see also Loy 1983; Gurfinkel 1987; Gurfinkel and Franklin 1988). Blood cells could also be introduced to the tool when refurbishing tools previously coated with animal blood, particularly hunting tools and weaponry. Study specimens EeRk 4:19-2119 (Figure 12k) and EeRl 7:1000 (Figure 12n) from the Mid-Fraser River region both produced weak positive reactions for blood, which may be due to any of the possibilities mentioned above.

E.T. #8 has a short distal projection that frequently slipped off saskatoon stalks and branches during use, even when using the "guide" formed by the juncture of the hafting mastic and ventral face of the tool (Figures 10 and 43). This tool is morphologically similar to what might be expected for prehistoric tools whose concave margins and/or distal projection tips had been subjected to several resharpenings (see Figure 5a) and was nearing the point of being functionally exhausted. Although E.T. #8 functioned very well for stripping bark and woodworking, occasional slipping disrupted the cadence of the strokes, and constituted both a nuisance and potential hazard (see above). Consequently, it was concluded that tools with short projections were considered to have slightly less overall functional efficiency than those with longer projections.

All experimenters developed distinct individual motor pattern "styles" shortly after they became familiar with the features and capabilities of their tools, and the nature of the woody plant types being worked. For example, some preferred to place their index finger on the medial aspect of the "opposite" margin's dorsal surface when engaging the concave margin, whereas others opted to use their thumb. Sometimes both thumb and index finger were used alternately. Conspicuous shallow indentations created on the medial, or medial-distal sections of the "opposite" margin on several specimens in the prehistoric microwear sub-sample (e.g., Figures 8j, 12a, 12g, 15n, 18e and 19d) suggests that these features were intentionally installed to comfortably accomodate the digit of preference (see also Odell 1981b:207).

Stalks and branches were held in a variety of ways for both reasons of functional efficiency and/or personal preference (Chapter 7.6). Average pressure loadings and working speeds also varied between experimenters. Some always worked slowly, methodically, and gently, whereas others preferred to work more quickly, erratically, and aggressively (see Appendix 9). Motor patterns and working rates also depended on the mood of the experimenters, and often varied between use-episodes. All experimenters remarked that when a tool was used unhafted, it was used differently than when hafted, and hafted tools were much more efficient.

These idiosyncratic behaviour modes are regarded to have contributed to at least some of the microwear trace variability observed on the experimental sample of key-shaped formed unifaces (Chapter 8), and also on the 129 prehistoric study sample specimens (Chapter 6).

### Deer Antler Working

The experiments suggest that the concave margin edge was moderately effective for scraping and shaving the softened outer 1 to 2 mm of cortex on antler beams that had been either soaked or boiled. However, it did not function well for working the unaltered antler beneath the softened cortex, and thus did not permit any substantial alteration of the beams. Rapid deterioration and dulling of the concave margin edge occurred when unaltered antler was worked.

The "opposite" margin was not very effective for scraping and shaving soaked antler, as it required a rather awkward and forceful motor pattern that afforded poor mechanical efficiency. The distal projection tip functioned quite well for incising and engraving the soaked outer cortex, but not without incurring severe damage and attrition to the distal edge and ventral-lateral corners.

Because soaked and boiled antler were significantly harder to work with key-shaped formed unifaces once the softened outer 1 to 2 mm of the beams had been exposed and/or penetrated, it is obvious that any attempt to significantly modify antler using this technique would necessitate repeated soakings or boilings over long periods of time. Overall, soaking and boiling do not allow antler to be very easily modified by chipped stone tools. Similar observations and conclusions were made by Richards (1987:132) during experiments involving Cache Creek basalt (lithic Type 6) tools used on soaked deer antler.

Given the types of substantially modified antler artifacts found in late prehistoric components on the Plateau (e.g., digging stick handles, wedges, harpoon valves, barbed points, sap scrapers, figurines, etc. [see Richards and Rousseau 1987:91]), I argue that there are several other techniques that could have been used to manufacture such items more efficiently. Unifacial "spurred" gravers -- which are formally distinct from key-shaped formed unifaces, but are often made of similar lithic raw materials -- can very effectively create elongate antler tool blanks by implementing the "groove and splinter" technique. They can also be used to install fine functional details (e.g., barbs), and to incise linear decorative elements. Abraders made of sandstone, siltstone, or other raspy lithic materials are effective for rapidly wearing down substantial portions of antler beams and tines for shaping blanks, and further modifying blanks into finished tools. Large cobble choppers, hammerstones, and stone wedges can be used to remove large unwanted sections of beams, create large blanks, or make small splinter-like blanks. Numerous gravers, abraders, hammerstones, and small stone wedges have been found in late prehistoric components on the Plateau, suggesting that some, or perhaps all, of these antler working techniques may have been commonly employed.

All considered, I conclude that the primary function of prehistoric key-shaped formed unifaces did not likely involve significant modification of soaked or boiled antler. This inference is based on: (1) the overall low to moderate functional efficiency and relatively rapid rate of tool edge dulling associated with undertaking this task; (2) the great amount of time that would have been required to significantly alter antler using this technique; and (3) there are several other methods that are far more efficient for executing this task, and there is ample artifactual evidence for them.

Moreover, it is significant to note that key-shaped formed unifaces disappear from the archaeological record after about 1000 BP (Chapter 4.2), whereas a wide variety and abundance of highly sophisticated antler artifacts persisted, and even seem to have increased in frequency, after this date (see Richards and Rousseau 1987:45-46).

However, since the experimental component of this study indicates that key shaped formed unifaces can be used to minimally modify (i.e., scrape and incise/engrave) soaked and boiled antler with some success, it cannot be concluded that these tools were *never* employed for this purpose. Yet given the overall low to moderate level of efficiency associated with performing these tasks, I maintain that they were probably only very rarely executed, and consitute a possible secondary function of these tools.

### Deer Bone Working

Scraping and shaving soaked deer bone was associated with a low level of functional efficiency and success. This is attributed primarily to the fact that bone is a very dense, hard, and resistant contact material, and these properties do not appear to be significantly mitigated by soaking in water for extended periods. Significant alteration of bone could be more effectively accomplished using several, or possibly all, of the alternate methods described above for working antler. From a functional perspective, I am compelled to conclude that key-shaped formed unifaces were probably engaged very rarely, if ever, to work bone in prehistoric times.

In sum, the experimental component of this study indicates that key-shaped formed unifaces functioned most efficiently and effectively for working green woody plants. Seasoned wood was determined to be significantly more difficult to work than green wood. Soaked and boiled antler were harder to work than seasoned wood, and could be minimally, but not significantly altered. Soaked bone was the most difficult material to work, and could barely be modified in any manner.