This thesis is not the place to rewrite the history of micro
wear analysis, nor to evaluate in detail all the pros and cons
of the method. Though a relatively new field of research, its
possibilities and impossibilities have been extensively stud-
ied by other analysts. Some attention will be given to this
matter, but the point of focus in this chapter is the applica-
tion of micro wear analysis on different types of chert
rather than flint. This project has a pioneering character,
and consequently a number of problems with the method,
specific to the analysis of stone types other than flint, had
to be confronted and solved along the way. As it was not
certain whether the observations made on experimental flint
artefacts could be used as a reference, an experimental
program on chert was part of the project. The choice of
experiments and the results will occupy the second half of
this chapter.

4.1 Wear trace analysis

4.1.1 INTRODUCTION
Wear trace analysis has gone through many stages until it
became what it is today: a mixture of methods and
approaches. Where in the past there used to be opposite
camps concentrating on either the low power (Tringham
et al. 1974; Odell 1981; Odell-Vereecken 1980; Shea 1988)
or the high power method (Keeley 1976, 1980; Keeley &
Newcomer 1977; Vaughan 1985; an overview in Cook and
Dumont 1987; Juel Jensen 1988), by now most (but not all)
analysts agree that the best approach is to use all available
sources of information to come to a functional inference
(a.o. Bamforth et al. 1990; Van Gijn 1990, 1998; Olausson
1993; Grace 1990; 1996; Fullagar 1998). The reliability
of the different approaches was and is continuously checked
by blind tests, either carried out by individual researchers
(e.g. Shea 1988) or by research groups especially composed
for this purpose (Newcomer, Grace & Unger-Hamilton
1986; Unrath et al. 1986).
The pioneering years were mostly dedicated to the discovery
and description of modifications that took place in or on
the tool’s surface during use (Semenov 1964; Keeley 1980).
Once it was established that not only edge removals,
striations and different degrees of edgerounding, but also
polish could be read as an indication of specific use,
attention shifted towards issues like the formation of polish
(Anderson-Gerfaut 1980; Fullagar 1991) and to the devel-
opment of methods to objectify micro wear analysis, like
expert systems (Grace 1989, 1996; Van den Dries 1997) and
programs for quantification of use-wear (Grace, Graham &
Newcomer 1985; Grace 1989). Besides, as yet another
direction of research, the analysis of residues is developing
rapidly (e.g. Fullagar 1994, see section 4.1.2.3).
The discussion over technological matters is accompanied by
a debate concerning the specific archaeological problems
that can and should be addressed with functional (use wear)
analysis. Although it is stressed that the analysis of micro
wear traces leads to interpretations and not to absoluteiden-
tifications of use (Van Gijn 1990), tool functions can now be
established with a degree of certainty which overrules that of
the suppositions made on typo-morphological grounds.
Obviously one of the first points to be assessed is the valid-
ity of these suppositions. Analysis of the correlation between
the morphology of formal artefact types and function is a
main subject of this study. It appears that tools that seem to
be specifically designed for certain tasks were often multi-
functional and used for a variety of unexpected activities
(e.g. Cahen, Keeley & Van Noten 1979; Fullagar 1994).
Modern typology is by no means a reflection of prehistoric
functional tool design (also Shea 1988).
When tool functions can be inferred, activities, tasks,
activity centres, site functions and intra- and intersite
relations may be established as well (a.o. Juel Jensen 1988).
However, the line from tool function — via ethnoarchaeol-
ogy and experimental archaeology — to a model for prehis-
toric behaviour should be drawn with great caution (Van
Gijn & Raemaekers 2000). Each prehistoric context and
site formation process is unique. Therefore, it cannot be
assumed that there is a necessary correspondence between
as tool’s form and function in different contexts at all times
(e.g. Ramos Millán 1990; Knutsson 1990).
In general, retouched formal tool types reflect only a small
part of total assemblages. In the past, unmodified flakes
were easily overlooked or not considered to be possible
tools. One of the insights gained by means of micro wear
analysis is that tools should also be looked for among the
The results of the experiments were, in general, positive. Most activities did produce some kind of wear traces, also on the coarse chert types. These traces are comparable with those found on flint tools, though less extensive. In general, polish will first form on the higher parts of the micro-surface, and only after prolonged contact will it invade the lower areas. Therefore, due to the granular surface of most tools and to the limited time of use, polish spots would not develop so much as to cover extensive areas (see further 4.2.3).

The sample from the site Galindo was analysed as the first archaeological test case. The results of this analysis are presented in chapter 5. These were promising enough to continue with the project.

Based on the results of the pilot study, finding traces on the coarser grained chert types was expected to be difficult, but possible. On these artefacts, an underrepresentation of certain activities that do not tend to leave much traces (working soft materials and non siliceous plants) would be taken into account (for a system of quantification of this representativity see Van den Dries & Van Gijn 1998). On the other hand, traces on the artefacts made of finer grained chert should be as clear as on most types of flint. It was also expected that traces would be unknown due to the fact that the tropical or subtropical setting is a relatively new area of study. With the selection of appropriate experiments and contact materials, part of this shortcoming might be solved.

4.1.3 Materials and methods

Sampling

The samples were taken in two ways. Those from the sites on the High Plain were selected from samples that had already been selected by the excavators, whereas those from the sites in the valley were chosen using the author’s criteria.

The excavators of Galindo and Tequendama had selected what they called “representative samples”, meaning that most of the traditionally distinguished tool types were included and that the sample consisted mainly of “most probable tools”. As one of the aims of this project was to establish the usefulness of the traditional typology for functional inferences, it was decided to select the artefacts to be analysed from this preselected sample. This also included a representative part of “atypical” or miscellaneous flakes. Besides, considering the expectations based on the raw material and the expedient character of the artefacts, it was thought wise to include artefacts with the highest possibility of having interpretable wear traces. The Galindo sample was given to me with a typological label for each artefact. For the Tequendama sample the artefacts were (probably was not always correctly) reclassified prior to analysis according to the descriptions of the excavators (Correal & Van der Hammern 1977; see also Ch.1; Ch.5).

Material from the sites in the Magdalena Valley was selected by the author from all available artefacts, and was not based...
on the typological classification made by the excavators. Criteria for selection of these artefacts were morphological aspects (like those described by Van Gijn, 1990): presence of straight edges (see also e.g. Juel Jensen 1988), small non-intentional edge removals, protruding points, polish visible with the naked eye and (in a very limited number of cases) striations on the surface of the artefact. Only after analysis did I rearrange the artefacts according to the traditional typology (see further Ch.6). In this way the analysis would be least influenced by functional suppositions based on formal typology. Most of the selected artefacts were made of various types of chert. A small sample of quartz artefacts from the Magdalena Valley was included as well. Obviously the degree of representativeness is questionable for the samples from both areas. In the first place there are some gaps in the documentation on the totals of excavated artefacts, both from the sites on the plain and in the valley. For Tequendama and Galindo the numbers could be reconstructed to a certain extent, but for the valley sites there was no way of knowing the exact percentage of the total assemblage chosen for analysis. Besides, as mentioned earlier, these sites were only small testpits, which adds to the problem as it implies that one can not speak of “complete” assemblages. Where the reconstruction of site functions is concerned, the statistical validity of the analysis is therefore reduced. However, the validity of the inferences on correlations between morphology and function is not affected by the lack of contextual data. As the analysed samples are relatively small, conclusions could be drawn by observing the figures in the tables. Therefore it was decided that no statistical tests would be carried out to support the inferences. Table 4.1 is a schematic overview of the sites and the specific research objective that could be addressed with each sample.

Table 4.1 Sites and research objectives

<table>
<thead>
<tr>
<th>OBJECTIVE</th>
<th>Tequendama</th>
<th>Galindo</th>
<th>La Palestina</th>
<th>Puerto Nare</th>
<th>Peñones de Bogotá</th>
<th>La Miel</th>
<th>San Isidro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form-function</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Abrian vs Tequendamian</td>
<td>x</td>
<td>–</td>
<td>x</td>
<td>–</td>
<td>x</td>
<td>x</td>
<td>–</td>
</tr>
<tr>
<td>Site function</td>
<td>x</td>
<td>x</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>x</td>
</tr>
<tr>
<td>Diachronic changes</td>
<td>x</td>
<td>x</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Exploitation of studied areas</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Though not completely similar, the hierarchy of analysis would follow a scheme as proposed by Grace (1990) to study complete assemblages: a first selection was based on typology and edge morphology, followed by a low power edge wear analysis which would finally lead to high power analysis of a smaller sample.

Micro and macrowear analysis: methods

Initially both high power and low power microscopy would be applied, as it was believed that the integration of both methods would be most informative (Van Gijn 1990; Schreurs 1992). If low power observations appeared to be sufficiently informative, a quick preselection of probably used tools could be made to be further analysed with the high power equipment. Thus large samples could be analysed in a very efficient way.

It was not known beforehand whether the analysis of edge wear on the coarse types of chert would be successful. According to some researchers there is no remarkable difference between the patterning of edge removals on various types of raw material (Tringham et al. 1974; Odell 1981; Shea 1988), while others have experienced differently (Keeley 1980). A stereoscopic microscope (Wild M3Z) with two obliquely reflected light sources, magnifying from 10x to 160x was used for the analysis of edge removals (“low power”). For the “high power” analysis a Nikon-Optiphot metallographic microscope was used with 10x, 20x and 40x objectives and 15x oculars. On the coarse grained chert artefacts polishes could not be interpreted at less than a 200x magnification, often 600x gave the best results. The finer chert types were mostly first observed with 150x or 300x and only occasionally with 600x.

The artefacts from the sites on the High Plain, from the site La Miel in the Magdalena Valley and from San Isidro in the
Cauca Valley were first cleaned with an HCl solution in water in an ultrasonic tank for five minutes, and subsequently cleaned with a KOH solution in water for another five minutes. The artefacts from the remaining sites were not chemically cleaned, as they would be checked for residues as well as for wear traces. These were only cleaned with water in an ultrasonic tank. All artefacts were cleaned with alcohol during analysis.

As it was expected that the characteristics of the various wear traces might be different from those on flint, a large number of variables was registered at the start of the project. The forms used for registration were an adapted version of the ones used by Van Gijn (1990; see also Appendix II). However, this changed in the course of the project, as not all variables were thought to be relevant. When it was concluded that the edge removals were not useful for functional inferences and the polishes mainly appeared to differ quantitatively and not qualitatively, many of these data were no longer recorded as they were not expected to be used for any purpose. Only when the polishes were unknown, were these characteristics recorded.

Six categories were distinguished for final inference of the analysed artefacts. When traces were clearly visible and a contact material could be interpreted, the tools were registered as “Contact material interpreted”. In those cases where traces were observed, but a contact material could not be inferred with certainty, the artefact was grouped as “Probably used”. The following category, “Uncertain”, comprised artefacts on which a minimum of traces was observed, but which could not with certainty be related to use. When there was no evidence of use the artefacts were classified as having “No traces”, and when the visibility of the traces was too low due to post depositional processes (patina, burning, edge damage) they were classified as “Not interpretable”. Hafting traces were distinguished on a number of used tools, these were also recorded separately. As a reference for the analysis of a small sample of quartz artefacts from the Magdalena Valley, use was made of published data (Fullagar 1984; Knuttson 1990, Sussman 1985,1988).

Residue analysis
It soon became clear that on the artefacts made of coarser chert, the distribution, termination and direction of edge removals did not display such systematic use-related patterns as described by specialists in low power analysis (e.g. Shea 1988). This implied that low power microscopy was no option to pre-select “probably used” artefacts. On the finer chert from the valley, edge removals did often display interpretable use retouch patterns, but these samples were so small that they were planned to be analysed with high power microscopy anyway.

Furthermore, as on the artefacts from the High Plain of Bogotá, polish formation was minimal due to the coarseness of the chert and probably to the short time of use, the possibilities for interpretations remained limited. On implements of this raw material, “certainly used” artefacts could be distinguished, and worked materials in a number of cases, but on the whole the level of inference was felt as unsatisfactory.

In the past ten years the analysis of organic and non organic residues on stone implements has been developed into an important tool for functional reconstruction. Microscopic elements of processed plant, animal and (bio)mineral products, like starches, phytoliths, resins, hairs, feathers, collagen etc. appear to be incorporated in, or attached to the surface of the tool and preserved for thousands of years, if buried under favourable conditions (Anderson 1980; Barton 1990; Fullagar 1991). According to a number of researchers pre-historic blood can be detected with specific testing methods (Loy 1990; Brass 1998; Garling 1998; but e.g. Eisele et al. 1995; Fiedel 1996; Furby 1996; Furby & Loy 1994).

Although preserved plant residue can be species-specific (sometimes pollen, phytoliths, starch and resin), there are numerous microscopic elements that can only be indicative on the family level. Phytoliths from Gramineae (Anderson 1981), and from a large variety of (sub)tropical plants (Piperno 1988, Piperno & Holst 1998) have been extensively studied and appear to be a helpful source of information for functional inferences on stone tools. The presence of starch can be evidence of processing “storage organs” like roots and tubers or other starchy plants like palm.

The integration of micro wear and residue analysis extends the possibilities of functional studies of lithic artefacts. As stated in the beginning of this chapter, a mixture of techniques proves to give the most satisfying results. Residue analysis was seen as a possible solution of the problems encountered during the wear trace analysis of the Colombian chert. Especially on coarse grained cherts, on which traces do not develop easily, residues may have been trapped in the surface and still be present. Like with use wear analysis, the analysis of residues rests on knowledge from experimental references, but to build reference collections it is essential to know which remains are likely to be preserved. Previous to selecting the cleaning methods for analysis, it should be considered that the chemicals used for micro wear analysis may destroy the residues. Similar to “traditional” micro wear analysis, residue analysis is passing through its developmental stages. An important item under research is the problem of soil contamination, as it is crucial to know whether supposed residues are related to use and are not merely a deposition from the sediment (e.g. Therin 1998; Fullagar, Loy & Cox 1998). For the present study no soil analyses were carried out, but other
parameters were taken as an indication that residues were use-related. The presence of residues was in most instances put side by side with information gathered from micro wear analysis, and when in accordance with the initial — micro wear — inference, they were considered to be use related. Extrapolated to the rest of the sample from that site, the residues found would then strengthen the interpretations of artefacts with uncertain micro wear traces.

The material analysed for the present study was partly cleaned with chemicals. In a number of cases it appeared that in spite of this cleaning, organic remains remained and were considered to be from use (e.g. San Isidro, Appendix I). The artefacts from Tequendama and Galindo had already been chemically cleaned (by myself) before it was decided that residue analysis would be carried out. Though chemical cleaning did not at all times destroy residues, on the artefacts from Tequendama not much seemed to have been preserved. This may be due to cleaning, soil conditions or postdepositional processes. The valley artefacts had only been cleaned by the excavators and were not chemically cleaned for micro wear analysis. Therefore they were in better conditions (Ch.6). Correal and Van der Hammen (1977:45) state that the preservation conditions for plant remains at Tequendama are not very favourable. Still, these conditions seem to have been far better than in the (sub-)tropical Magdalena Valley. On the Plain in general there are more organic remains found at the sites than in the more acid tropical soils. This is relevant for residue analysis.

Though you may not need to be a specialist (biologist or chemist) yourself to recognize and identify microremains (see Van Gijn 1998), assistance from various specialists is required for the correct identification of residues. It has been my experience that in the initial phase of research in this field my basic knowledge on microfloral and faunal remains and of chemical analytical procedures was insufficient. Building a reference collection helped to overcome this to an important degree (see further section 4.2.3).

4.2 Ethnography and the experimental program

4.2.1 INTRODUCTION

The knowledge on wear trace formation is based on experimental data. Most scholars engaged in macro and micro wear studies have carried out experiments, starting with the pioneer of wear trace analysis, Semenov (1964), who based his interpretations in part on experiments and on analogies with contemporaneous tool use. It is tempting to rely on previous reference collections instead of designing new experimental programs parallel to every larger micro wear project. There are prehistoric tasks that have been replicated so frequently that it is hard to believe that one more time could give new information. It is important not to fall into this temptation, as not one single experiment can cover all variables that influence the formation of the package of micro wear traces that are being studied. A good example of a new insight gained by additional experimenting when an answer seemed already established, is the interpretation of “sickle gloss” on a sample of Dutch “sickles” that were apparently not used to harvest grasses but to cut sods (Van Gijn 1992).

As Wear trace formation on the raw material studied in the present project was unknown, experimentation was necessary. Also, the (sub) tropical ecological setting called for new experiments. The reference collection available at the Institute of Archaeology, Leiden University, was built from experiments carried out with European flint on material from a specific European context. A large number of possible contact materials from a different context, that had not been studied thus far, was required to study their formation of traces.

4.2.2 SOURCES OF INFORMATION

The experiments were chosen on the basis of data from three different types of sources. The most direct basis of information is obviously the archaeological context itself. Botanical and faunal remains from a number of preceramic sites excavated in Colombia inspired the selection of some experiments. Secondly, there are the colonial and ethnohistorical references, which can give valuable information on material culture from the first centuries of colonization. The third, and probably most informative source, is modern ethnography. Hypotheses that need to be tested experimentally are often primarily based on ethnographic analogies (a.o. Van Gijn & Raemaekers 2000). Wherever possible, it was tried to find analogies close to the area of study. For each material with which experiments were carried out, data from these three sources will be described when available.

It appeared to be very difficult to find references on the general use of stone artefacts, both in colonial and ethnohistoric sources and in modern ethnographic accounts from the study area. Stone tools are found at most archaeological sites from the ceramic, pre-conquest period, which would suggest that flaked implements were still widely used when the Spaniards arrived. The Spaniards introduced metal tools and weapons. It was initially forbidden for Indians to possess these modern materials (Patito 1992, 5:170) and stone fell into disuse gradually. Post conquest writers had to draw their data from oral information (Gumilla 1741). However, in their extremely extensive descriptions of the Indian lives and practices, the chroniclers seldom made reference to the use of flaked stone implements. Descriptions of cobbles used as pounding tools, like manos and metates, or of polished tools like axes, are easier to find. Apparently these were more notably used when the colonists arrived. Therefore, finding references on tasks which were then carried out
with flaked stone artefacts in these early works, is a complicated, if not impossible task.

A relatively “modern” source of ethnographic information is the Handbook of South American Indians (Steward 1963). Most data on the use of flaked stone tools however, refer to archaeological finds. Only a minimal number of modern uses are mentioned. The Arawak on the Venezuelan North coast reportedly used daggers and knives of flint and flint chips. They also make celts of stone or shell of petaloid shapes, of which the pointed butt is inserted in a cleft in the handle and bound with a cord (4:243). The Charrua in the actual territory of Uruguay are said to use arrows and spears tipped with tanged stone heads (TI: 191-194).

A source from the past decade with ample descriptions on daily subsistence tasks and domestic activities is Patiño (1992). Writing about hunting and fishing he mentions that this is done with spears and arrowheads, but the tips are seldom made of stone. Most are fashioned of wood, cane, mammalian bone and fish spines (ibid: 55, 77). In a chapter dedicated to “utensils”, Patiño specifies that these were either of plant (e.g. cane knives, gourd containers), bone, turtle shell or shell origin, but he fails to describe how these tools were manufactured. When he mentions that the most common tools for daily tasks, were made of stone, he refers to archaeological remains and not specifically to more contemporary observations (ibid: 111).

4.2.3 THE EXPERIMENTS

A total of 63 experiments was carried out with chert artefacts in Leiden and Bogotá. The artefacts were manufactured with direct percussion and in most cases were not retouched. Tabular blocks of coarse and medium chert from different locations on the high plain of Bogotá (Nemocón, Galindo terrace), and finer chert river cobbles from a number of locations in lower areas (Natagaima, Chaparral, and the rivers Tuluni and Tetuan), was used as raw material.

Forty experimental tools were cleaned after task completion with a 3% HCL solution in water and a 10% KOH solution in water, both for five minutes. The tools were rinsed with alcohol before being studied. Other tools were not chemically cleaned, as they were primarily destined to be checked for residues. These were first observed on the tool’s surface and where possible extracted and mounted on glass slides to be preserved for permanent reference. Some of these artefacts were also checked for polishes and other wear traces after cleaning with alcohol. As expected, wear traces were not always easily distinguished due to the the residues still present. When archaeological tools are analysed for residues it is preferably to clean them as little as possible. Post depositional processes have probably already eliminated most of the residues that were present directly after use. It is considered important to check artefacts for “traditional” wear traces without first trying to erase all residues with chemical solutions.

The experiments were generalized and not specifically task or problem oriented: the general aim was to set up a basic reference collection of traces formed on various chert types, controlling three variables: movement, contact material and duration. In the first instance it was not known whether interpretable traces would develop at all on the selected types of chert. Some artefacts were only used for a very limited time, as most of the archaeological implements probably had not been used for long before being discarded: especially on the tools made of coarse chert the edge would wear quickly (e.g. boring holes in shells, after seven holes the tool could not be used any longer). Code lists and general data are presented in Appendix II.

Bone

Bone implements were found at nearly all preceramic sites on the Bogotá plain. These are mostly simple fragments or splinters of broken bone, sometimes intentionally pointed or shaped into knife or scraper-like artefacts. At Tibo a fragment of mastodon rib was found with paralell incision lines, interpreted as being the result of butchering (Correal 1981, p. 123, foto 31). At Checu a bone flute was found, dated around 8000 BP (Groot de Mahecha 1992).

experiments

Two experiments were conducted on bone, and on both tools specific bone polish developed after 10 minutes of use. The polish would certainly be identified archaeologically. It has the same characteristics as “bone polish” on flint: it covers the higher areas of the microsurface, is flat and matt and contains “comet tails” when well developed. One of the implements was made of very coarse chert. (Fig. 4.1)

Butchering (meat, hide, tendons and bone)

The presence of large numbers of bones of consumed animals at Tequendama and much fewer at Galindo is an indication that butchering may have taken place at these sites. Besides the hunted animals, there are some indications of early domestication of *Cavia porcellus* (IJzereef 1978; Peña & Pinto 1996). For Galindo it is hypothesised that small triangular shaped flakes may have been used for butchering (Pinto 1991). There are no further specific ethnographic references on butchering methods for the area.
Six butchering experiments were carried out on deer, cow and guinea-pig (*Cavia porcellus*). One implement was only used on cavia for five minutes, as it appeared unsuitable to even cut through the skin. One deer and one cavia experiment were performed adequately and gave a reasonably positive result. They displayed the expected mixture of traces from soft, medium and hard material due to contact with hide, flesh, tendons and bone (Fig. 4.2). There is a greasy band of lustre along the edge, within which small spots of matt, flat polish can be found. The artefacts with these traces were interpreted as butchering tools when found archaeologically, but no clue on the butchered animal would be given. One artefact used to butcher a cow hoof (detaching meat and tendons from the bone) was only checked for residues, which consisted of hairs, blood and collagen (fig. 4.3).

**Fish**

Fish remains are found at different late preceramic, formative and ceramic sites in the coastal areas. In the interior there is mention of fish remains at Aguazuque (dated between 5025 ± 40 BP and 2725 BP, Correal 1990:109), but there is no mention of fish bones at early preceramic sites. However, the location of artefact scatters near water and the presence of large numbers of triangular shaped flakes is sometimes interpreted as an indication that for the early occupants fish was an important part of the diet. These flakes were associated with fish processing (Correal 1977). There is no doubt that fish was consumed in the different areas in Colombia, at all times. However, it is less certain that stone tools were used for processing fish. It is known for several North American cultures that they used tools to
prepare fish for preservation (see Van Gijn 1990). I have not found ethnographic accounts on specific tools for processing fish in South America, except that in Brazil (Tupinamba, Steward 1963, 3:103) and in Venezuela (Llanos, ibid 4:465) they are ground into a sort of pemmican or flour for preservation, a task that had to be performed with grinding implements. The fish mostly appear to be either smoked, boiled, dried or salted without further preparation like gutting or scaling. Only the Aymara from the Andean region are said to split the fish and clean it before drying (ibid 2:527).

In spite of the lack of referential data it was decided to conduct some experiments. Expecting fish to be a problematic contact material (see e.g. Van Gijn 1986), special attention was given to this category and the experimental results were considered to be surprisingly positive. Polish observed on a number of archaeological tools (Guayabero and Galindo) strongly resembled the distinctive fish polish found on experimental flint implements as described by other researchers.

Ten tools were used to work Bocachico (*Prochilodus magdalenae*, Cecil Miles 1971:134,136, plaatje), a fish that is plentiful the whole year through in the Magdalena. It can not be caught with hooks but has to be captured with nets. Seven of the experimental tools were cleaned chemically and checked for wear traces. On the other three the residues were checked and extracted where possible.

Traces as described by Van Gijn were obtained in a number of cases, like a band of polish with a greasy, bright appearance away from the edge. Four had diagnostic polish (after 5 (!) and 25 minutes of use) (Fig. 4.4).

On one this was well developed. On three (one uncleaned) the traces were too small to be specific. On the remainder only the residues were analysed. These consisted of fragments of skin (Fig. 4.5) and scales and would lead to a secure interpretation when found on an archaeological implement.
Hide

It is important here to make a distinction between different climatological environments. In general it seems that in cooler regions hide processing is a more complex task than in warmer, tropical areas. This is most probably related to the fact that in cooler areas hide is an indispensable material for the manufacturing of protective clothing and shelters, whereas in warm, tropical settings the use of hide for clothing is, unless for decorative and/or status-related purposes, not a realistic option.

Among the Abrian artefacts one of the largest type categories consists of different classes of scrapers (like lateral, end, discoidal, multiple), which are mostly associated with hide working. At Tequendama, two bone fragments of Mapuro (Conepatus sp., a type of skunk) were found (dated between 9500 and 8500 BP). This animal may have been hunted for its skin. There is one late colonial reference on the appreciation of skins as valuable goods. Indians along the Orinoco hunt an animal referred to as “mapurito” or “mafutiliqui”, and give special attention to its skin, which is kept as a precious good. No further description of processing is given (Gumilla 1741:291).

There are some contemporary references on hide processing and use by tribes in tropical and subtropical environments, specifically in Colombia (Steward 1963). There are, however, no details on the instruments employed to carry out the processing tasks. For example, the Ica in the Sierra Nevada de Santa Marta in the North are said to “use skins somewhat more than other tribes of this region, but work of this material is unimportant throughout the mountain regions. Tanning is unknown” (2:881). The Yagua from the lower Putumayo and Napo are said to make hunter’s pillows, for which they scrape and soften, but do not tan, feline and beaver furs (ibid 3:732). The Witotoan tribes from the Para Paraná and Upper Caquetá use furs, again untanned, for pouches and shields (ibid 3:754).

A less obvious “hide-processing” task is said to have been performed by tribes from the Cauca Valley: they seemed to have layed the corpses of slain enemies and stuffed the skins with wood ashes, the potash of which preserved them for some time (ibid 4:305).

Tribes from the Guianas use hide for sandals, the heads of drums, public coverings, pouches for carrying small articles and straps. Hides are not tanned and leather working, properly speaking, does not exist (ibid 3:844-845). The Lenca from the Northern Panamenian Highland have always used skins of wild animals (jaguar, watusso and deer skins), which they scraped, stretched and dried in the sun, without using any curing agent (ibid 4:211).

On a few occasions, scrapers are described that are used by tribes from cooler areas. The Aymara from the Titicaca Basin scrape dried hides with a knife and then work the contents of the animal’s stomach into the skin with their hands and feet. The cured skin is then worked with a porous lava rock. Hair is removed by applying hot ashes and then scraping with a stone. In Bolivia, hides are soaked in salt water and then limewater for 2 weeks. Dry hides are used as surfaces to grind grain and for transporting manure, fuel and fish. With the hair removed, hides are cut into strips and made into two-ply rawhide ropes and lassos (ibid 2:535).

Scrapers made of mussel shell lashed to a cylindrical stone haft are used by the Yaghan (Cape Horn; ibid 1:89). Fleshers, in which a stone or glass blade is set at an angle to the handle, are used by the Ona (Tierra del Fuego; ibid 1:112-113) and scrapers with flint, agate, obsidian or glass blades lashed to a bent split sapling (or set transversely in a block of wood) are used by Patagonian and Pampenan hunters (ibid 1:148, fig. 8g).

Experiments

Five artefacts were used to work fresh hide, and five to work dry hide. The tasks included scraping off grease, flesh and hair, cutting and piercing. In general it can be said that the polish — when it develops — is identical to that which is found on flint tools, though on the coarser cherts the amount of polish is less extensive. The polish is rough and cratered in a band along the edge (Fig. 4.6) and in one case the edge is rounded. The hides worked were from deer, tigrillo (a small feline), cavia and snake (Boa constrictor). There is a difference between polish from a relatively thick hide (deer) and from a very thin skin (snake). On four artefacts the polish was so characteristic for hide that this would certainly be interpreted as such when found on an archaeological implement (this includes the snake skin experiment). One of these is from very coarse chert; it had very well developed traces after using the tool for 30 minutes on dry hide (Fig. 4.7). On two implements traces did develop which
were too weak to be recognized as being from hide on an archaeological tool, and on two there were no traces observed at all.

The tool used to scrape fresh skin of a Boa Constrictor was not chemically cleaned. It did have a medium developed polish that was recorded as indicative of scraping thin hide, but not specifically from snake. It is similar to the polish obtained on some artefacts used to work rabbit skin.

Turtle shell

Fragments of turtle shell were found in many coastal sites, which are all from the ceramic period. An example of such a site is Monsú (Podocnemys lewman and Kinosternon leucostomum; occupation from 5300 BP onwards, Dolmatoff 1985). On the High Plain of Bogotá a complete turtle shell (Kinosternum postinolate) was found at the ceramic site Aguazuque (from 5025 ± 40 BP, Correal 1990). It is supposed that turtles were consumed, and it is possible that this was also done in the preceramic period. The carapace may have been used as recipient or as raw material for the fabrication of other artefacts. One of the fragments found at Monsú was shaped into a possible scraper, while another one was perforated and possibly used for decoration. The example from Aguazuque was intact, meaning that it may not have been used. However, it is supposed that for most purposes the upper part of the shell has to be separated from the lower part.

experiments

Two artefacts were used in an attempt to separate the lower part of a turtle shell from the upper half. This was not accomplished, and, to my surprise no traces appeared to have developed on the artefacts. In spite of being a hard material, comparable to bone, the edge merely wore off and only a non diagnostic spot of polish formed on one of the tools.

Agave

In Colombia and the surrounding areas, species of agave are used for a large variety of purposes (Agave americana, Agave fourcroyoides, Agave cocuy). In the Sierra Nevada de Santa Marta, agave is cultivated and carefully tended by Indian tribes as source of fiber for making mochilas (bags), string and rope (Steward 1963, 2:873-874). In this same area the Ica use Agave to make the fermented drink Chicha (ibid, 5:542). In Mexico, Agave is used for making pulque, mescal or tequila (the stem is hollowed, juice is extracted and stored in gourds to ferment). The plant has many medicinal applications, and use of fibres for ropes or textiles is widely known (Perez Arbelaez 1992:165-6). No mention of specific tools for the extraction of the fibres is made. One remark is made on one part of the processing task after separating the fibres: these are rolled on the thighs to make string (Orinoco area, Steward 1963, 5). Although there are no indications of the use of Agave in preceramic times, it was decided to conduct one experiment, considering the fact that it has been an important material from historic times onwards and its use in earlier periods should not be excluded.

experiment

One tool was used to cut and scrape Agave leaves in order to work out the juice and isolate the fibres. Only a very weak polish developed, not strong or characteristic enough to be identified. Residues consisted of green plant juice filled with elongated fibres on which high concentrations of small, ovalate cells were stuck.
Cassave

Cassave (Manihot spp.) is not known to have been used in the early preceramic period. Signs for the earliest use of this root crop are implements called budares, used to bake flat cassave breads of bitter manioc flour, after the tuber has been processed. Small stone flakes are sometimes interpreted as elements that were originally inserted in wood to make a composite grinding tool used to scrape cassave. The oldest in Colombia are dated ca. 6000 BP (San Jacinto). However, as the possibility of earlier use should, again, not be excluded, four artefacts were used to cut and scrape cassave.

experiments

On two only, generic weak polish developed, certainly not diagnostic of cassave. On another tool, no polish developed at all. From two implements the residues were checked and extracted. These consisted of large numbers of starch grains (Fig. 4.8). Form and size of starch grains can be species-specific, but it is not known whether this modern, industrial cassave starch would be identical to that found on an archaeological cassave tool. Starch occurs widely in plants, but especially in roots, tubers, seeds and fruits. The amount found on a tool might be seen as an indication of processing these parts (though most fruit — except e.g. palm fruit — does not need to be processed with flaked stone artefacts.

Gourd

One gourd fragment was found at the rock shelter of Zipacon I (dated 3270 BP; p. 173, foto 177:28.8) It was painted with ochre (Correal Correal & Pinto 1983). In Colombia, gourd is used for innumerable purposes. After processing, the hard outer shell can be transformed into cups, spoons, dishes, musical instruments and other containers. Besides, the soft inner pulp is used to treat several illnesses.

The Tenetehara in northeastern Brazil (Tupi-Guarani speakers) boil gourds, allow them to dry, cut them in half and then scrape them out. They use the gourds as jugs for drinking (Steward 1963, 3:538).

experiments

Before gourds can be used as containers for any kind of storage, the outer skin has to be peeled off. Then it has to be cut in two and the inner part has to be extracted and scraped. These tasks were experimentally performed with four tools. On two of these, polish developed that would be interpreted as plant polish when found on an archaeological tool, but it would not be recognized as being from scraping gourd. No rounding and no indicative edge removals were observed. Residue found on one of the implements consisted of plant tissue with very bright, starlike spot. It is not known yet whether this may be considered specifically indicative of “gourd tissue”.

Gramineae

The oldest evidence of prehistoric use of Gramineae in Colombia consists, as far as I know, of some fragments of burnt bamboo found at the site Sueva (Bogota Plain, 10,000 BP; Correal 1979). Much younger are remains of chusque (Bamboo sp) found at the site Aguazuque (Bogota Plain, 5025-2725 BP). These were found in a posthole that formed part of a circular pattern of holes, which were interpreted as being from some sort of covered housing construction (Correal 1990).

The use of different kinds of Gramineae like cane and bamboo as raw material is known in all (sub)tropical areas (e.g White and Thomas 1972; Golson 1977). These plants were and are still widely used in South America, both in the highlands and in the tropical regions. The sharp edges of bamboo splinters make them very suitable for cutting tools,
arrow and spear heads, shafts and other implements. Colonial references on the use of this material for the fabrication of weapons and other purposes are easily found. *Cerbatanas* (blow pipes) used to be made from bamboo (Patino 1990, 5:81). The use of cane and bamboo for constructions is described in Simon (1627, 3:185) and Patino (1990, 1:14). In Gumilla (1741:267) there is one interesting reference on the use of arrows of *cañabrava* used specifically to hunt caimans. In modern ethnographic accounts there are also numerous descriptions. The use as domestic tools and arms is for instance described for Indians in eastern and central Brazil (Botocudo, Batovi, Cawahib: Steward 1963, 1:383, 535; 3:140, 289, 325), Venezuela (Guarani, 3:5), Paraguay (Bororo and Guayaki, ibid p. 425-440) and Bolivia (ibid 31:452). Indians in Eastern Brazil are reported to use a section of the hollow bamboo stem as a container for cooking or holding water (Steward 1963, 1:383). In a separate chapter on weapons, detailed descriptions are found on the use of specifically *Gynerium sagittatum*, *Guadua* sp. and *Arundo donax* for arrowshafts, lanceolate bamboo blades for game hunting, bamboo tubes as blowguns (Metraux in Steward 1963, 5:239-263).

Unfortunately it is never reported how these implements were made: whether they were cut with stone tools or sharpened on a stone surface is not mentioned. However, we can assume that stone tools must have been used. There is only one tiny remark on this by Steward (1963, 3:289), concerning the Cawahib living along the upper Tapajoz river in Brazil. They use a large game and war arrow with a lanceolate bamboo head (40 cm) the edges of which are made razor sharp with an instrument consisting of a cutia tooth (*Dasypoeca aguti*) attached to a handle.

experiments

Different kinds of Gramineae were used to experiment with, both from the cool areas like the High Plain of Bogotá (*Chusquea* and *cañabrava* de Castilla = *Arundo donax*) and from more tropical areas (*Guadua angustifolia* and *caña pindo* or *cañaflecha* = *Gynerium sagittatum*, Pérez Arbeaæz 1990:398; this specific cane is used by Indians to make arrowheads, which accounts for the second name, meaning “arrowcane”). In total, seven artefacts were used to work this material. Scraping *Guadua angustifolia* for 30 minutes resulted in a polish that might be confused with wood polish on an archaeological tool. It is very bright and smooth and tends to form a thin line along the edge. On all other artefacts, including a very coarse grained tool, areas of flat, smooth and generally matt polish developed that would be recognised as being from silicious plant (Fig. 4.9). There is no difference in the polishes of the various species of cane used for these experiments. Residue on one of the artefacts con-

sisted of a bright folded tissue, but it is uncertain whether this is typical for cane. On one chemically cleaned artefact some white fibres were still visible.

Palm

That palm fruits were consumed in early prehistoric times is suggested by fragments of Palm endocarps found, for example, at San Isidro and Peña Roja (Gnecco 1994; Cavelier et al. 1995; Morcote et al. 1998). Specific pounding tools and stones with small depressions (“nutting stones”) found at various later sites may well have been used for processing palm fruits. It is very probable that all parts of a large variety of palm species were used for different purposes from the earliest period of occupation onwards.

There are extensive ethnohistorical and modern ethnographical reports on the use of different species of palm trees in the northern part of South America. Gumilla (1741) gives very detailed descriptions of the use of palm trees by the Indians living along the Orinoco river. The Palma de moriche (*Mauritia flexuosa*) was used almost for everything by the guaraninos in the Orinoco delta: to eat, dress, build, make boats etc (ibid: 11):

(...) todo su vivir, comer, vestir a su modo, pan, vianda, casas, apero de ellas y todos los menesteres para sus piraguas y pesquerias y varias mercancias que venden, todo sale de las palmas (...) (Gumilla 1741:69).

He mentions that the Indians work with axes now, but that they used to cut and further process the trees with fire (ibid: 71). No further tools are described. Modern ethnographic studies have been carried out in different regions in Colombia. Studies of the Nukak Maku in the Amazon have yielded much information on the use of different varieties of palms (Morcote et al. 1998), but there are no specific references to the use of stone tools.

experiments

Although palm fruits are not likely to be opened with flake tools, but were probably cracked on a stone surface, two artefacts were used to work palm (*Scheelea butyracaea*). One of these was used to peel the skin off a palm fruit, the other one to scrape the wood. Both developed polish and on one this was a mixture of “soft wood” and “siliceous plant”. “Palm” would not be specifically inferred on basis of this type of polish. However, among the residues found on both artefacts, a remarkable number of raphides was found (Fig. 4.10). Apparently these are frequent both in palm stem and in palm fruit. No significant amount of starch was found among the residues, this is due to the fact that in this experiment the fruit was not opened. When this combination of polish and residue would be found on an archaeo-
Fig. 4.9 Experimental polish of silicious plant. a-Chusque, orig. magn. 100X, b-200X, c- 400X; d-Caña brava, 200X

Fig. 4.10 Experimental residue: Palm-tissue, starch and raphites, a-non polarised, b-polarised, orig. magn. 200X
logical artefact, I would most probably interpret this as related to processing palm wood or fruit, depending on the artefacts morphology.

**Wood**
To my knowledge, no wooden artefacts were found at any site in Colombia or the surrounding areas, due to preservation conditions. The use of wood for tool manufacture and other purposes is, however, widely suggested, not only by the proposed correlation between concave edges and woodworking but also, for example, by the choice of site location in or near forested areas and by the presence of fireplaces at different sites (e.g. Tequendama, Galindo, San Isidro).

**Experiments**
Fourteen tools were used to work three varieties of wood: birch (there are various kinds of Betulaceae now in Colombia, these are probably imported species: Pérez Arbeláez 1990:218), oak (first appearance of Quercus in the Andes around 250,000 BP, Van der Hammen 1992:40), and Caracolí (a local medium hard wood, Anacardium excelsum, Pérez Arbeláez 1990:172). Six of the implements were not cleaned as they would be checked for residues. In general the observed polish was a very clear, typical wood polish, either forming a thin bright line along the edge or a reticulated pattern covering the higher areas of the surface. When soft wood was worked, small spots of polish developed that are similar to ”silicious plant” polish (Fig. 4.11). One medium hard wood developed a polish similar to polish on bone working tools, but brighter.

On seven of these tools diagnostic wood polish developed. Three of these belong to the uncleaned sample, but nevertheless the polish could be clearly distinguished. On three, the polish is so weak that it would not be recognized on an archaeological tool. One had no traces at all. The residues found on the artefacts used to work medium hard wood (Caracolí) consisted principally of reddish, resin like layers on the surface. There were also fragments of white tissue and tiny pollen grains and/or starch.

**Shell**
Small shells of land gastropods and larger fresh and saltwater mollusks have been used for several purposes from early preceramic times onwards. Among the many gastropods found at Tequendama, there was one shell (Orthalia sp.) with four pierced or drilled holes. It can be assumed that small snail shells were used for decorative purposes. At the late preceramic site Aguazuque, shell beads were found, which must have been pierced/drilled with either bone or stone tools (Correal 1990). Among the skull fragments found at this site, there are some which are decorated on the inside with a nacreous substance, possibly extracted from fresh water mollusks (Aniconides, Correal 1990:141). Tools made of large marine shell fragments (Strombus gigas), shaped like adzes were found at coastal sites (for example Monsu, between 5300 and
1200 BP, Dolmatoff 1985). Fragments of *Strombus gigas* were also found on the High Plain of Bogotá, at the rock shelter Zipacón I (3200 BP, Correal & Pinto 1983) However, it is unlikely that flake stone tools were used for their manufacture.

experiments
Only one artefact was used to make holes in small shells, combining a drilling and piercing motion. It was only used for five minutes and then discarded because it was too much worn to continue with the task. No traces developed.

4.2.4 Conclusion
As a general conclusion it can be stated that polish appeared to be the most — if not only — indicative wear trace. Edge rounding and striations were only observed in a very limited number of cases and edge removals did not develop according to known use patterns. In some cases, specific residues were observed that could give additional clues on the worked material. As will be seen in the following chapters, the inferences on the archaeological implements were made principally on the basis of polish. In a number of cases, the presence of residue was decisive for a final inference (tables in Appendix II).