RASPADITA, A NEW LITHIC TOOL TYPE FROM SANTA ISABEL, NICARAGUA

BY

JOLENE DEBERT

A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfilment of the Requirements
For the Degree of

MASTER OF ARTS

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RASPADITA, A NEW LITHIC TOOL TYPE FROM SANTA ISABEL, NICARAGUA

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JOLENE DEBERT

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirement of the degree

Of

Master of Arts

Abstract

A new lithic tool type was discovered at the Pacific Nicaraguan archaeological site of Santa Isabel (AD 800-1350). The tools are unifacal and range in length from 0.5 to 3.0 cm, in width from 0.5cm, and are less than 1 cm thick. Their proximal ends are convex with edge angles clustering from 70° to 110°. The distal ends are tapered to a blunt point. The proximal and distal ends are separated by the midsection, which slopes steeply towards the tip and contains some retouch, but minimal usewear. This tool type was named raspadita (small scraper).

Statistical analysis showed the raspaditas to be a distinct class of artefacts. It was determined that the raspaditas were manufactured from bladelet cores using soft hammer percussion and pressure flaking unifacial retouch. Spatial and usewear analysis confirmed that the raspaditas formed part of a composite tool with a ventral leading, dorsal following unidirectional scraping motion.

Four possible functions were investigated using scanning electron microscopy (SEM) and residue analysis for the raspadita composite tool; manioc grating, fish scaling, maize processing or general grating. The usewear and residue analyses support maize processing or general plant grating, rather than manioc grating or fish scaling.

The Pipil-Nicarao, who inhabited Santa Isabel are a Mesoamerican cultural group. But raspaditas have not been found in northern Nicarao sites, implying a southern impetus for their invention. The Nicarao's interaction with Southern cultural groups may have served as the stress that created these new food-processing tools.

Acknowledgements

I would like to thank my advisor, Dr. Barbara L. Sherriff, and committee members, Dr. E. Leigh Syms, Dr. Gregory G. Monks and Dr. Lea Stirling for their support and guidance. A special thank you to Dr. Sherriff who blindly took on my project and then followed me through the hinterlands of Nicaragua and Costa Rica. Thank you, I appreciate it more than you will ever know.

Thank you to Dr. Geoffrey McCafferty who's SSHRC grant provided the funding for the Santa Isabel project and for his encouragement throughout my undergraduate and graduate career; you may turn me into a Mesoamericanist yet. I would also like to thank the Santa Isabel field crew, who are to numerous to mention by name, but were invaluable. A special note to Larry Steinbrenner who helped with the Nicaraguan archaeological history, thanks Mister Nicaragua. I would also like to thank Dylan McCafferty and Sean Morton for their help with the lithic data collection and Marco Ortega for his technical support, both in and out of the field.

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Finally, I need to thank my mom, dad, Chantel and Joe, as they formed my support system and were integral in the maintenance of my sanity. Without their encouragement none of this would have been possible.

Table of Content

List of Figures:

List of Tables

Glossary

Antibody: A protein produced by the immune system to defend against foreign proteins.

Antigen: A foreign protein that causes an immune response.

Arris: A dorsal ridge formed by the intersection of two or more flake scars, running from proximal to distal ends.

Asymmetric raspadita: A raspadita without a mirror plane of symmetry.

Atole: A thin gruel, made of maize flour and water, typically drank.

Biface: A lithic tool with manufacture retouch on both major surfaces.

Blade: A flake that is twice as long as it is wide, greater than 5 cm in length and produced on a specialized prepared core.

Blade core: A specially prepared core, from which blades greater than 5 cm in length are removed.

Bladelet: A flake that is twice as long as it is wide, less than 5 cm in length and produced on a specialized prepared core.

Bladelet core: A specially prepared core, from which blades less than 5 cm in length are, removed.

Blank: A useable piece of unmodified lithic material.

Bulb of percussion: A core or diffused core shaped bulge on the ventral surface, caused by Hertizian fracture.

Bulbar fissures: Fine lines or crevices on the surface of the bulb of percussion.

Chromatography: A category of technique used in the separation of complex mixtures, includes gas chromatography and electrophoresis.

Chontel: An indigenous ethnic group, speaking a dialect of Matagalpa and inhabiting the Central Highlands of Nicaragua.

Chorotega: Both an indigenous ethnic group and language. They speak an Oto-Manguean language of Mesoamerican origin and are located in Southern Honduras, Central Pacific Nicaragua and North-western Costa Rica.

Crossover immunoelectrophoresis (CIEP): An antigen-antibody immune reaction test in which a reaction indicates the species in the sample

Distal end: The end of a flake or tool containing the termination, opposite the platform and proximal end.

Dorsal surface: The outward surface of a flake prior to its detachment from a core; often containing negative flake scars, and the arris.

Drill: A perforating tool used in a twisting or rotational motion.

Edge angle: The angled formed by two surfaces of a tool.

End scraper: A scraper with the working end on the proximal or distal end of the tool.

Enzyme-linked immunosorbant (ELISA): A quantitative analysis that involves linking a specific antibody or antigen to a microtitratron plate.

Eraillure scar: A small flake scar on the surface of the bulb of percussion.

Feather termination: A form of the distal end, that gradually thins to a thin edge.

Flake: A small piece of lithic material broken off of a larger piece.

Formal lithic tool: A tool with a standardized form, requiring substantial retouch.

Greater Nicoya: A culture area stretching from Western Honduras to Northern Peru.

Hertzian fracture: A forward progressing fracture that is deflected back due to compressive stress, and forms the bulb of percussion.

Informal lithic tool: A tool lacking a standardized form, without substantial retouch and is often called an expedient tool.

Mesoamerica: A culture area extending south from Central Mexico into Central America, including parts of Guatemala, Belize, El Salvado, Honduras, and Nicaragua.

Metate: A stone block with a concave surface, used with a mano for grinding corn or other grains.

Mono: A long stone with a circular or ovate cross section used with a metate for grinding corn or other grains.

Nahuatl: A language Uto-Aztecan language of the Mesoamerican origin.

Nahua: A general term used to discribe, speakers of Nahuatl, with simular cultural characteristics.

Nicarao: A group who speak Pipil-Nahuatl and who lived in the Isthmus of Rivas, Gulf of Fonseca, Central Guanacaste and possibly Panama at the time of Conquest.

Perforator: A pointed implement used to pierce, punch, or bore a hole, using a non-twisting motion.

Pipil-Nahuatl: A dialect of Nahuatl spoken in El Salvador and Nicaragua.

Pipil-Nicarao: A group inhabiting El Salvador and Nicaragua, speaking Pipil-Nahuatl.

Platform: The region on the flake, that the hammer or fabricator makes contact with to detach it from the core. It is contained on the proximal end.

Platform scars: Scars contained on the platform surface as a result of previously detached flakes.

Pressure flaking: The removal of small to medium sized flakes by applying pressure to the surface of the lithic material.

Proximal end: The end of the flake that contains the platform and is opposite the distal end.

Radioimmune assay (RIA): A quantitative analysis that involves linking a specific antibody or antigen to a microtitratron plate and uses radioisotopes to detect the antigen complex.

Scanning Electron Microscopy (SEM): A technique that uses an electron beam instead of light to magnify and form images.

Soft hammer percussion: Lithic tool production utilizing a fabricator made of bone, antler, or wood, designed to remove lithic flakes.

Spokeshave: A concave scraper.

Step termination: A form of the distal end that nears 90 degrees.

Striation: Scratches produced by abrasive particles on a tools edge during use.

Symmetric raspadita: a raspadita with one longitudinal plane of symmetry.

Tamales: From Nahuatl *tamalli,* it is a traditional foodstuff made with maize flour mixed with water and lard. Meat or cheese is added and then wrapped in plant leaves or maize husks, and cooked.

Tortillas: A thin circular disk of unleavened bread made from maize flour, water and lime water; which is baked on a hot surface.

Unifacial: A tool manufacture with retouch on only one of the two faces.

Ventral surface: The inner surface of the flake that was created when it was detached from the core, containing the bulb of percussion.

Utilized flake: A flake that exhibits small flakes that were removed as a result of being used.

Chapter 1: Introduction

1.1 General Introduction

The purpose of this thesis is to determine if raspaditas, new lithic tools found at Santa Isabel, Nicaragua, are a coherent new group and if so to define that tool class. The characteristics of the raspaditas were compared to those of other lithic tools from Santa Isabel. The source of the chert used to manufacture the raspaditas was also sought.

Nicaragua, in the middle of Central America is a bridge between North and South America, both geographically and culturally. It is located between the culture areas of Mesoamerica and Greater Nicoya and presents an opportunity to explore the Nicarao cultural frontier. Santa Isabel is located in Southern Pacific Nicaragua and was possibly Quauhcapolca the capital of the Nicarao (Figure 1.1) (Fowler 1989). It is a residential site, roughly 16 hectares, in size and contains at least ten house mounds (Figure 1.2) (Niemel 2002). It is approximately 500 metres from the shore of Lake Nicaragua and 30 kilometres from the Pacific Ocean, in the southern portion of the Isthmus of Rivas (Steinbrenner 2002).

The inhabitants of Santa Isabel are thought to be Pipil-Nicarao, a Nahuatl speaking group who migrated from Central Mexico (Lange 1984, Fowler 1989). The economy of the Nicarao was agricultural, based on the traditional staples of maize, beans and squash (Fowler 1989). Trade relations existed in both northern and southern culture areas, though contact with eastern groups was minimal (Lange et al. 1992). The goods transported included pottery, obsidian, jade and probably numerous perishable products (Willey 1984).

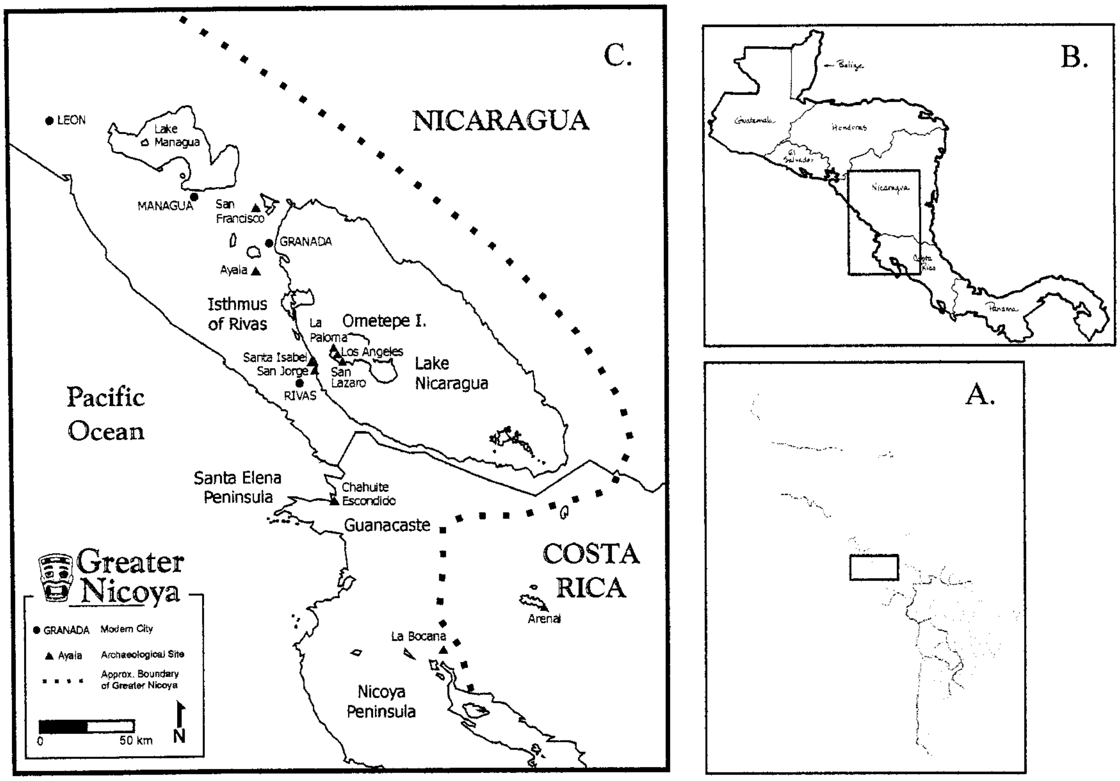


Figure 1.1 Pacific Nicaragua Location. (A.) In the Americas (International Network for Environmental Compliance and Enforcement) (B.) In Central America. (Texas State Library and Archives Commission) (C.) In Greater Nicoya. (McCafferty & Steinbrenner 2005)

Figure 1.2 Banana field, looking east at Mound 3, Santa Isabel.

Except for the imported obsidian, the majority of lithic materials were local (Lange et al. 1992). Part-time craft specialists manufactured the lithics, in a similar manner as pottery production (Lange 1984). The lithic tools include both formal and informal types (Lange et al. 1992). This thesis evaluates a new formal lithic tool class recovered from three seasons of archaeological excavations at Santa Isabel.

These excavations are the largest of their kind in the region. Willey and Norweb first reported the site in 1959-1961 (Healy 1980), though it remained relatively unexcavated until 2000. The site was dated to the Ometepe period (1350-1550 CE), based on diagnostic ceramics collected from the surface and later recovered from subsurface deposits (Healy 1980, Flowler 1989, Steinbrenner 2002, Niemel 2002, McCafferty et al. 2003). However, twelve recent radiocarbon dates (890-1290 CE) from the site places it in the ceramic Sapoa period (850-1350 CE) (McCafferty & Steinbrenner 2005).

A new lithic tool type, which had not been described previously, has been recovered from Santa Isabel. This is the most prolific tool type at the site, comprising over 70% of the formal tools. This new tool has not been reported from other contemporaneous sites in the region, which have been dated using radiocarbon and ceramic techniques. This may be a result of preferential sampling or incomplete analysis. Since there are no previous examples in the literature, the new tool was named, raspadita, which roughly translates from Spanish as small scraper. This name is descriptive both of the tool's size and possible function. The raspaditas from Santa Isabel are uniform in size, form and material type. These three traits influenced the functional hypotheses proposed.

1.2 Hypotheses

1.21 First Hypothesis: Raspaditas are a formal tool class

The first hypothesis is that the raspaditas form a coherent and unique lithic tool class. If the raspaditas are a proper lithic type then the defining characteristics of the group should be unique and have a degree of homogeneity that is statistically significant. This was explored using statistical analysis.

1.22 Second Hypothesis: Raspaditas formed part of a composite tool

The function of the raspaditas is the major component of this study. This is not straightforward, as the pointed form of the tool suggests a perforating function, whereas the opposite end usewear indicates a scraping function. The abundance of the tools in the collection, (70% of each season's lithic tools) and similarity of characteristics indicates that they are a distinctive tool class. This leads to the second hypothesis that the raspaditas formed part of a composite tool.

The composite tool would be composed of a number of raspaditas set into an organic material such as wood in a particular orientation (Figure 1.3). In this configuration the raspaditas would be inserted into one side with a similar orientation, to reduce breakage. The tip of the raspadita would be the portion inserted into the haft, and either held there by resin or mechanical forces.

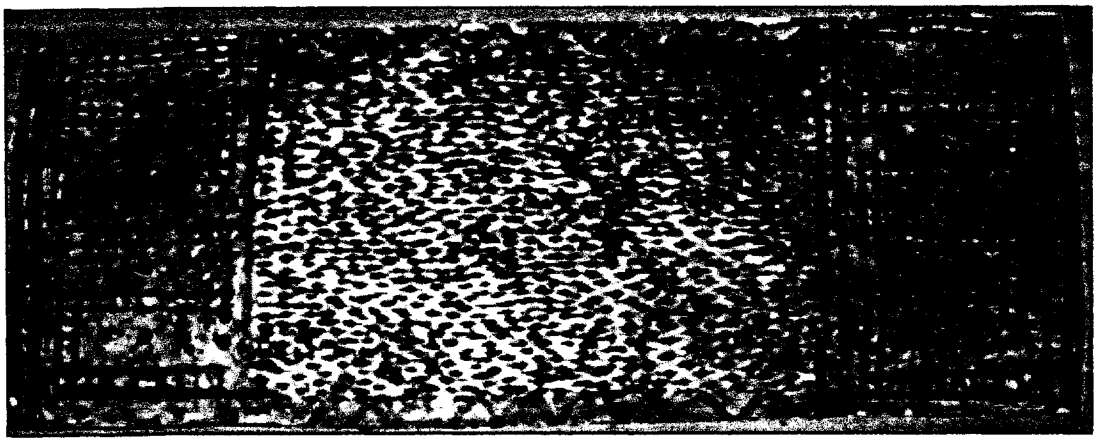


Figure 1.3 Composite tool: manioc grater from Museum National, San Jose, Costa Rica. Note: the orientation of the inserts in the centre of the board is parallel to the length. Scale bar is 10 cm.

1.23 Third Hypothesis: Raspaditas were manioc graters

The construction of the composite tool could be similar to the bitter manioc (*Manihot esculenta)* graters found to the south of Nicaragua (Sauer 1950). If the raspaditas were used as manioc grater teeth, orientated parallel to use then the end of the tool should show edge polish, microchipping, macrochipping, ridge polish and striations along the length of the use edge (Nieuwenhuis 2002). This usewear should be clustered at the lateral sides of the end and the striations should run parallel to the edge. The tip should show evidence of hafting such as spot polish, and sporadic rounding (Nieuwenhuis 2002). These characteristics should be without orientation, and may mask the minimal wear caused during insertion into the board.

Residues present on the tool surface may include resins from hafting and manioc starch grains. Manioc starch grains are distinctive in that they are the only known plants to have fissures on bell-shaped grains with centric hila, without lamellae (Reichert 1913, Bell et al. 1944). Therefore, if these features are discovered then presence of manioc can be confirmed. Manioc tubers do not contain phytoliths and, therefore, no phytoliths should be present in the raspadita residue. Although the manioc plant does contain phytoliths, these parts usually remain in the fields making their recovery unlikely (Hawkes 1989).

1.24 Fourth Hypothesis: Raspaditas were used as fish scalers

Another composite lithic tool from South America, the fish scaler, is similar in appearance to a manioc grater and often misidentified in the archaeological literature (Perry 2002). Traditionally fish scalers were made of wood and lithic flakes, but more recently ceramic fish scalers have been used. These ceramic boards are fish shaped and contain ceramic appliqués and/or incising instead of stone flakes (Perry 2002) (Figure 1.4).

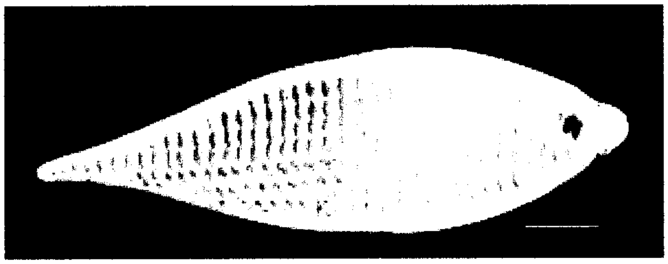


Figure 1.4 Fish scaler. Note the orientation of the ceramic appliqués is perpendicular to length. Scale bar is 5 cm (Florida Museum of Natural History)

The traditional lithic inserts are relatively unworked flakes, though a blunt edge is often selected or accomplished with retouch, before insertion (Tomenchuk 1997). If the raspaditas were used as fish scalers then the usewear generated should include edge polish, microchipping, macrochipping, ridge polish across the full end edge surface, striations perpendicular to edge with spot polish, and rounding on the tip.

The major difference between the usewear of a manioc grater and a fish scaler is the orientation. The lithic flakes in fish scalers are inserted with their width perpendicular to use. This means that the microwear will be distributed equally across the width of the end and the striations would be perpendicular to the edge. Additional evidence for a fish scaling function would be preserved fish scales or oils adhering to the surface of the raspaditas.

1.24 Fifth Hypothesis: Raspaditas were used to process maize

At the time of contact, the Spanish reported that the staple foods of the inhabitants of Pacific Nicaragua were maize (*Zea mays*) beans (*Phaseolus spp.*) and squash (*Cucurbita pepo)* like the diet of Northern Mesoamerican groups (Abel-Vidor 1981, Fowler 1989). Several traditional ways to prepare maize in Mesoamerica were recorded at the time of the conquest: tamales, tortillas or atole. The first step in the preparation of all three foods is the removal of the kernels, before they are ground into flour (Katz et al. 1974, Johannessen & Hastorf 1994). Ethnographic records from Mesoamerica describe the grinding of maize using a stone mono and metate (Figure 1.5 A, B), however, there is little to no discussion about the removal of the kernels and husks (Katz et al. 1974).

The people of Santa Isabel were growing hard Mesoamerican types of maize and harvesting it when the kernels and husks were ripe and at full strength following the traditional practice. This differs from the softer North American variety of corn, which is also harvested in a tender green state. If the raspaditas were used to process maize they were probably used with their width perpendicular for maximum strength and surface volume. This is the same configuration as the fish scalers and the usewear generated would be indistinguishable. This includes the edge polish, microchipping, macrochipping, ridge polish and striations perpendicular to length of the use edge and the typical signs of hafting on the tip. The best way to distinguish between fish scaling and maize processing would be to find maize starch grains and phytoliths on the raspaditas.

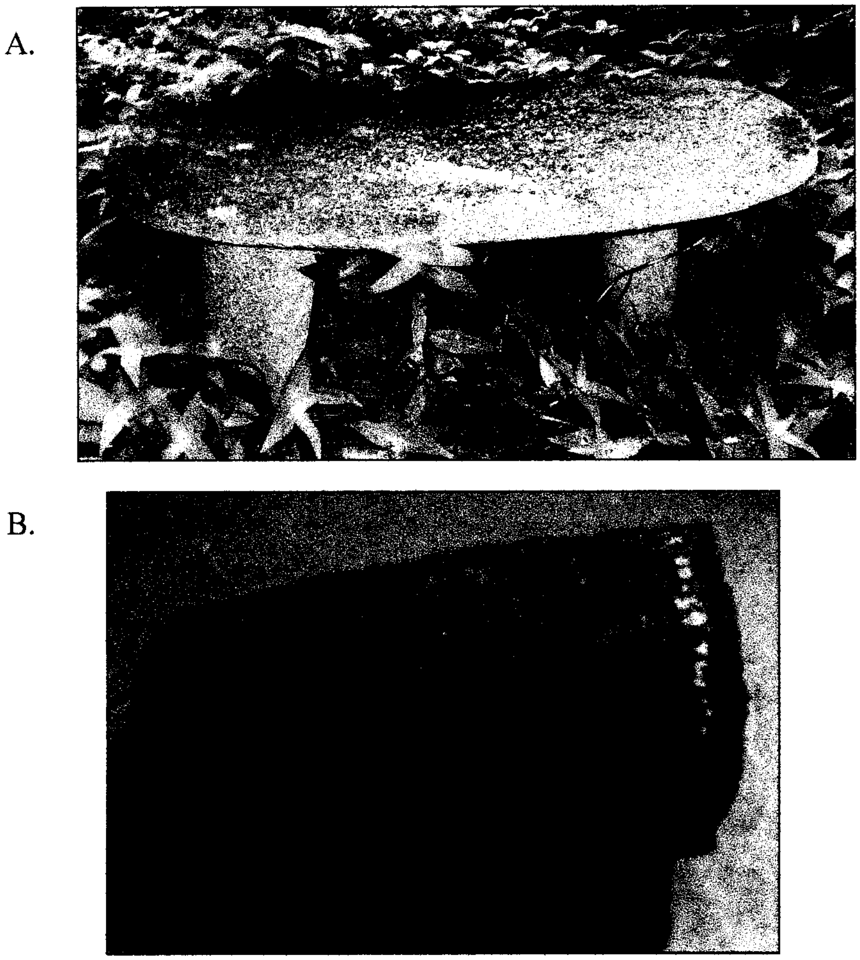


Figure 1.5 Mono and metate: (A.) Metate from Ometepe Island, roughly 50 cm in length (B.) Part of mono from La Arenera archaeological site, near Managua, Nicaragua. Scale bar is 1 cm.

1.24 Sixth Hypothesis: Raspaditas formed part of a general grating board

The final proposed function of the raspaditas is as a general grater, similar to modern analogies from North American kitchens. These boards are designed to work on a number of different shaped foods, as well as those of differing hardness. The impetus behind this hypothesis was Linda Perry's recent work in Venezuela, which has called into question traditional identification of manioc grater teeth (2002). The Venezuela grater teeth were analysed for residues and eight different species were found, none of which were a species of manioc (Perry 2002). This has led other researchers to question their functional identifications, which were based on morphology alone.

A pivotal feature of general grater boards is that they are used on a multitude of materials. Since the characteristics of the materials would fall on a spectrum, regarding both their hardness and the desired fineness, a general grater must be able to complete all these tasks. The orientation of the lithic inserts in the board is important; if they are placed parallel then a slicing action results; if placed perpendicular, a scraping function would result. If the materials were soft then smaller, thinner lithics could be used, but for harder materials, thicker pieces would extend the life of board. There would be differences in the mechanical properties of the lithic material. Most manioc grater inserts are made of obsidian, whereas, the raspaditas are chert. The fracture characteristics of the rock could also influence the shape of the inserts.

The result of these variables could be regional variations of the same general tool type, which would create a number of different patterns of usewear. They would be identical to that of the manioc grater board if the inserts were placed parallel, or the same as the fish scalers and maize processors, if the raspaditas were place perpendicular to use.

Additionally, patterns of usewear could include bi-direction uses, i.e. running the material back and forth on the board instead of one direction only and possibly rotating the same board 90 degrees to serve as both a scraper and slicer. Therefore, a general grater board could show signs of both perpendicular and parallel use, making a clear distinction from other functions. It is equally likely that a general grater would be used in only one standard configuration that would mirror a more restrictive function. Thus, the only way to identify this function would be from residues on the raspaditas.

	End Usewear				**Tip usewear**			
	Micro chipping (on edge)	**Macro chipping (on edge)**	**Polish (ridge/ edge)**	**Striations (to edge)**	**Micro chipping**	**Macro chipping**	**Polish**	**Striations (to edge)**
Manioc Graters	Lateral	Lateral	Lateral edges, ridges	″	Sporadic	Sporadic	Sporadic	Variable
Fish scalers	Disperse	Disperse	Edges, ridges	⊥	Sporadic	Sporadic	Sporadic	Variable
Maize process	Disperse	Disperse	Edges, ridges	⊥	Sporadic	Sporadic	Sporadic	Variable
General grating	Variable	Variable	Variable	Variable	Sporadic	Sporadic	Sporadic	Variable

Table 1.1: Summary of expected usewear. Note: ″ Parallel, ⊥ Perpendicular

These hypotheses were investigated using statistical analysis, functional determination and the spatial distribution of the raspaditas. The function was examined using a combination of scanning electron microscopy (SEM), and optical microscopy for residue identification. The cultural implications of these results were explored with relation to the migration of the Nicarao into the area of Santa Isabel.

Chapter 2: Physical and Humanistic Setting

2.1 Physical Environment of Nicaragua

Central America forms a land bridge between North and South America, with Nicaragua being located in the centre, north of Costa Rica and south of Honduras (Figure 2.1). The major topographic features of Nicaragua are the two central lakes. Lake Nicaragua, 160-km long and 72-km wide is the largest lake between the Great Lakes and Lake Titicaca. Lake Managua, northwest of Lake Nicaragua is smaller and drains into the larger lake (Figure 2.1). These lakes served prehistorically as important conduits for trade. They were among the leading candidates for the Trans-Caribbean canal (Healy 1980, Incer 2000).

Figure 2.1 Physical Nicaragua (Road Junky)

There are several volcanic islands within Lake Nicaragua including Ometepe (Haberland 1986), which contains two large volcanoes, Concepción in the north and Mandera in the south (Figure 2.2) (Haberland 1986). These volcanoes form part of the Central American Volcanic Arc, which is parallel to the Middle-American trench, extending from Mexico to Costa Rica (Figure 2.3) (Marshall & Anderson 1995, Chan et al. 1999). The Marrabios mountain range of Nicaragua is part of the Central American Volcanic Arc and is aligned along a NW-SE segmented line about 300 kilometres long (Marshall & Anderson 1995). This volcanic chain or arc changes to a more southernly direction close to the modern city of Managua (Ranero & von Huene 2000).

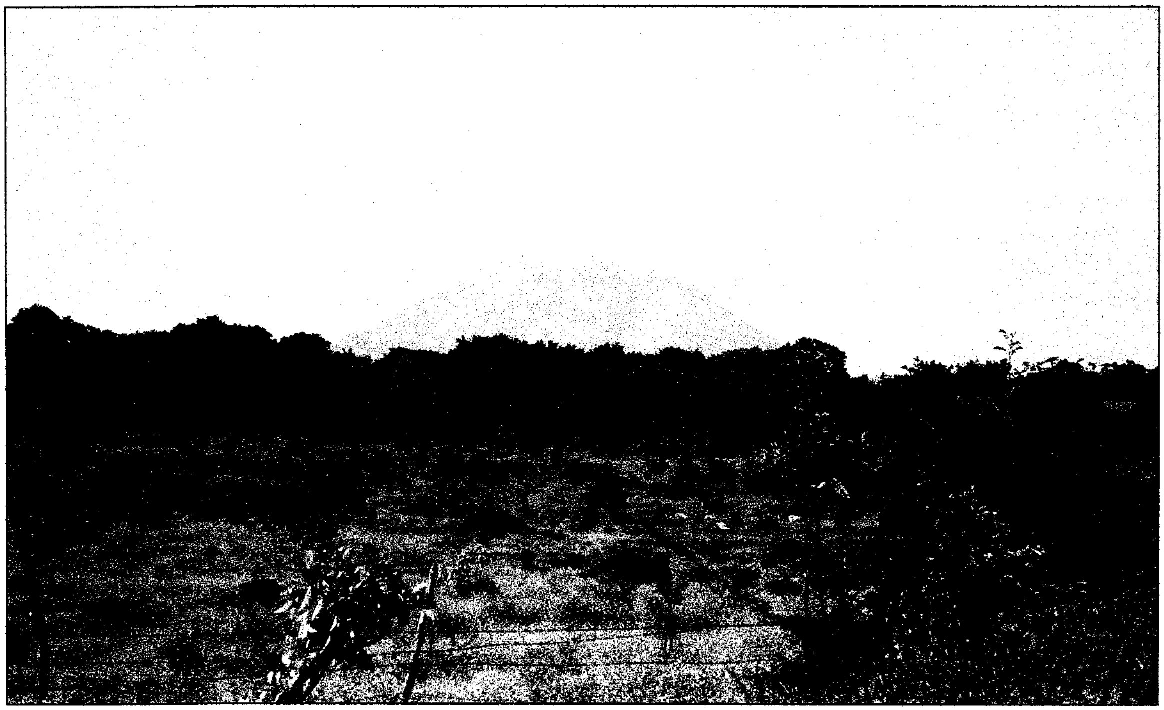
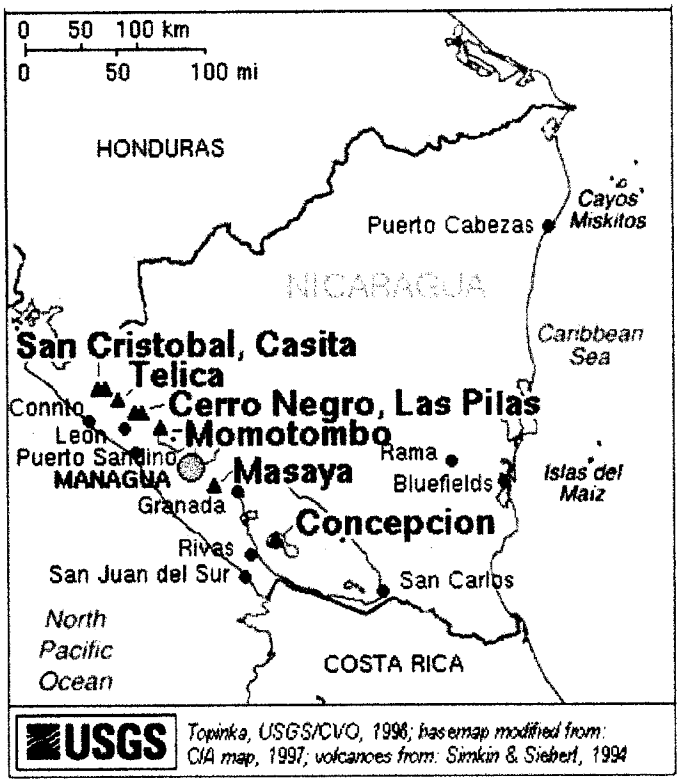


Figure 2.2 Concepción on Ometepe Island viewed from Santa Isabel.



Topinka, USGS/CVO, 1996; basemap modified from: CIA map, 1997; volcanoes from: Simkin & Siebert, 1994

Figure 2.3 Active Nicaraguan volcanoes. (USGS Smithsonian Museum, Department of Mineral sciences, Global Volcanism Project)

The active tectonic history of the region is caused by the Caribbean Plate and Cocos Plate being sandwiched between the three larger North American, South American and Pacific Plates (Figure 2.4) (Christeson et al. 2001). Most of Central America is located within the Caribbean plate, which is subdivided into a number of blocks separated by faults (Barckhausen et al. 1998, Hauff et al. 2001). The Motagua-Polochic Fault System bisects Guatemala separating the northern Maya Block from the southern Chortis Block, which includes Northern Nicaragua (Figure 2.5) (Christeson et al. 2001). The tectonic affiliation for much of southern Nicaragua remains undetermined (Barckhausen et al. 1998, Hauff et al. 2001). This tectonic activity has caused a diversity of depositional environments, deeply deposited structures, and economic mineral deposits (Chan et al. 1999).

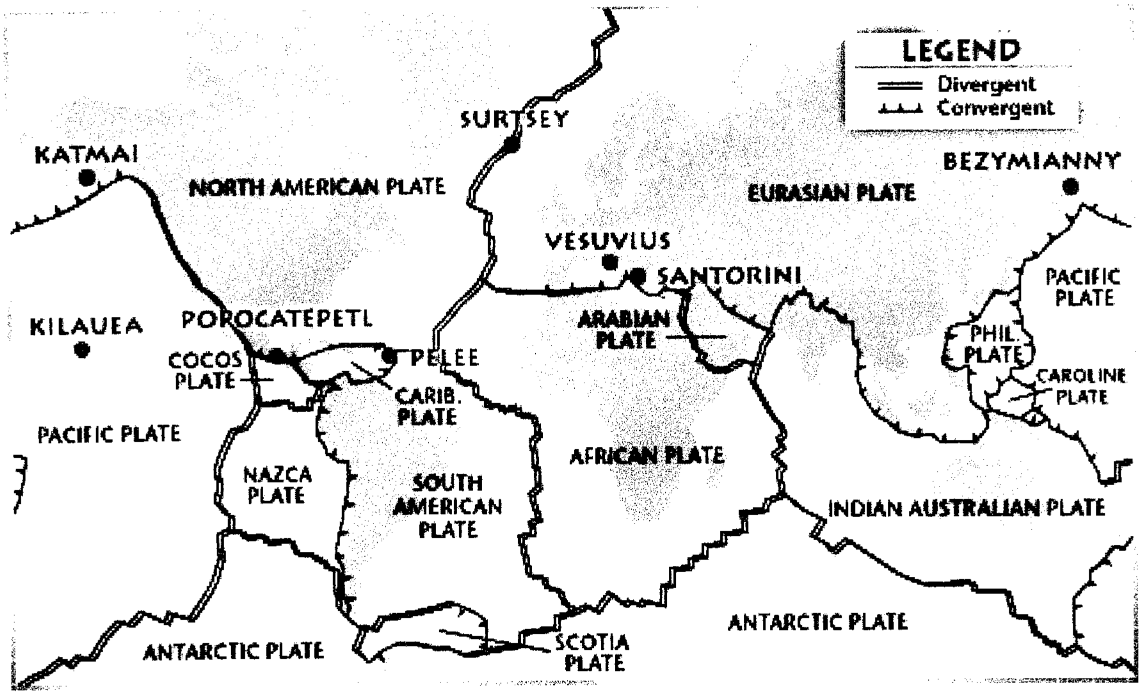


Figure 2.4 Global plate boundaries. Note Nicaragua's location on the Caribbean plate, with the Cocos plate subduction to the west.
(Annenberg/ CPB Exhibits)

There are two main seasons in Nicaragua, wet and dry. The dry season extends from December to April, and the wet from May through to November, with maximum precipitation in June and September. There is a mini dry season in the middle of July called the "veranillo", which is about two weeks long. The mean annual temperature for Rivas in the Pacific SW is about 27°C. Rivas has as average annual precipitation from 1500 to1800 mm (Healy 1980, Incer 2000). There is an increase in the level of precipitation towards the ocean with the Caribbean and Pacific coasts being wetter than central regions (Stone 1966, Healy 1980, Incer 2000).

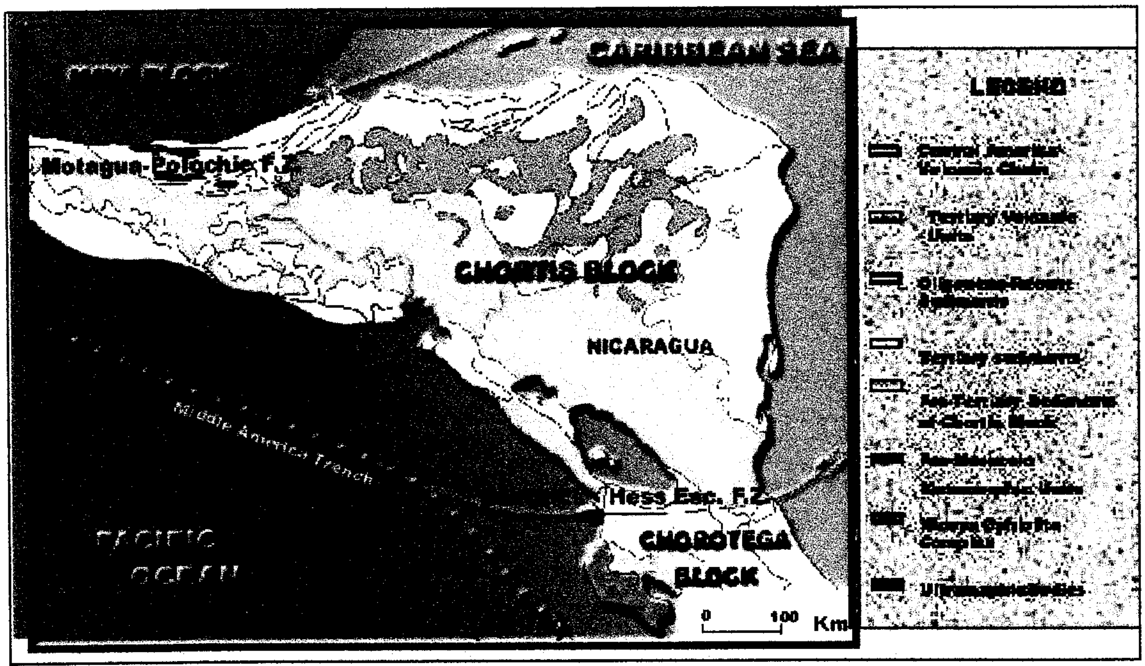


Figure 2.5 Nicaraguan geological block system. Note: Tertiary deposits dominate the Isthmus of Rivas. (Sundblab et al. 1991)

Nicaragua is divided into three regions, Pacific coast/Nicaragua depression, Central Highlands, and Eastern/ Northern Nicaragua, based on geology, topography, climate and vegetation (Figure 2.6 A, B).

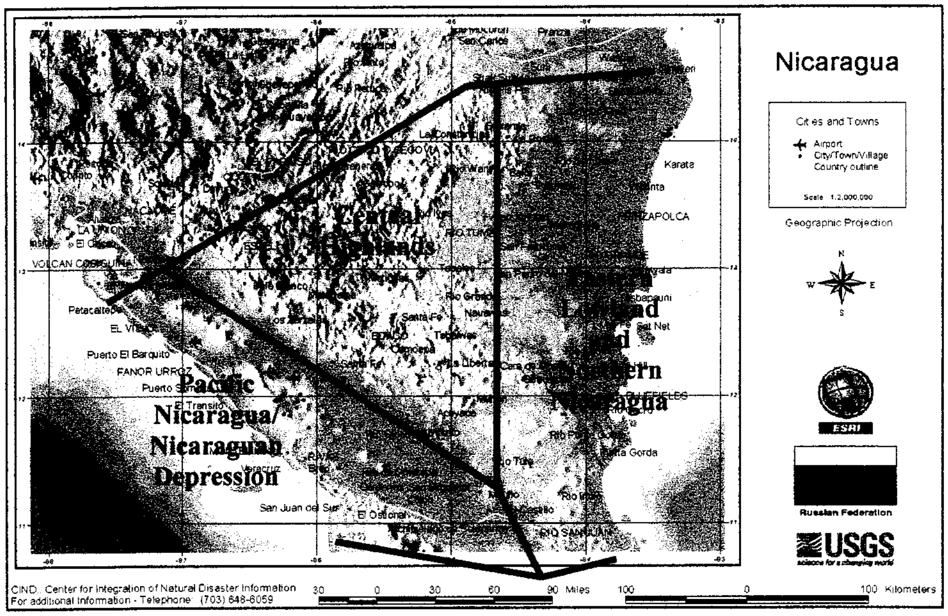
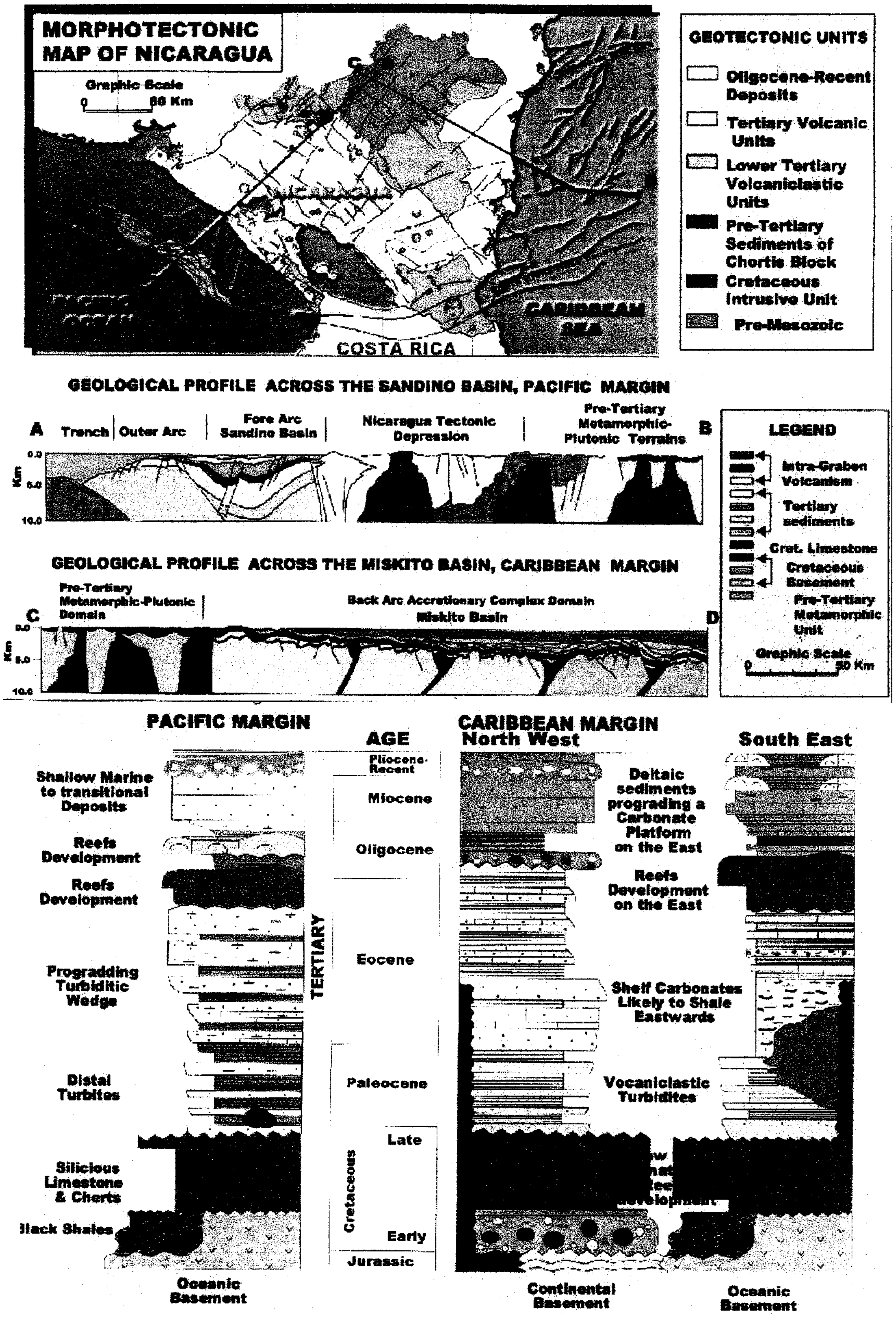


Figure 2.6 A. Geographical divisions of Nicaragua. (University of Texas at Austin, Perry-Castañeda Library Map Collection)



B. Geologic units and cross-sections of Nicaragua. (Sundblab et al. 1991)

2.11 Eastern and Northern Nicaragua

The Eastern Lowlands are located east of the Nicaraguan Depression and directly north of the Nicaraguan-Costa Rican border (Figure 2.6A). The Eastern Lowlands constitute just over 50% of the landmass of Nicaragua. The crust in this region has been found to be continental from lead isotopic and other geochemical data. The San Juan is the major river in the region. It drains the inland lakes of Nicaragua and has numerous tributaries draining the valleys between volcanoes on the Caribbean slopes of the Costa Rican central Volcanic Range (Snarskis 1984, Elming, Rasmussen 1997, Incer 2000).

The Northeastern region consists of shallow marine deposits, which formed from the Oligocene to early Miocene periods. A series of carbonate banks and barrier reefs from Nicaragua and Honduras to Jamaica formed a barrier to northward flowing water causing a westward flow of oceanic surface water between the Caribbean and the eastern Pacific. During the early to middle Miocene the barrier collapsed allowing surface waters to mix. The change in oceanic currents, as well as the eventual closure of the Caribbean-Pacific oceans is recorded in the coccolith and sediment assemblages (Meschede & Frisch 1998, Cunningham 2000). Cretaceous limestone in the south is overlaid with Tertiary shales; which in turn are partial covered by younger Tertiary silts and sands (Meschede & Frisch 1998, Cunningham 2000).

The climate of the Eastern Lowlands is hotter and more humid than the Central Highlands. The predominate vegetation is pine and palm savannas, with tropical rain forest increasing in the south (Figure 2.7). The soil is generally leached and infertile making cultivation difficult with fertile land being confined to the natural levees and narrow floodplains of the rivers, which contain rich volcanic soil (Snarskis 1984, Incer 2000, Keegan 2000).

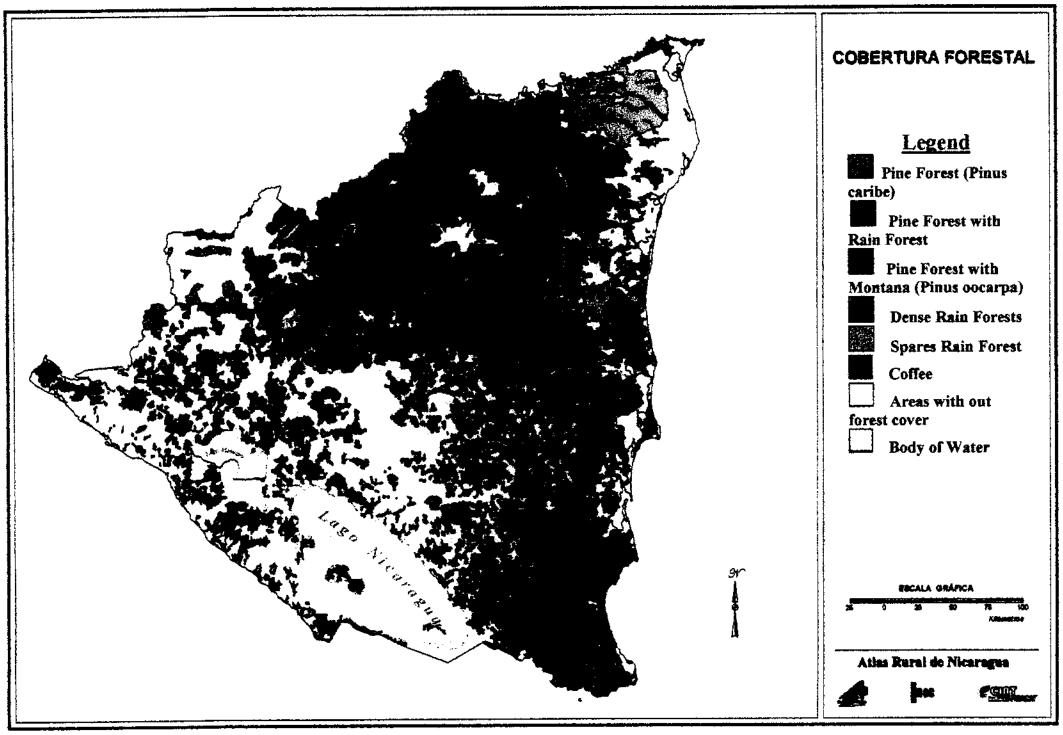


Figure 2.7 Nicaraguan vegetation. Note most of the Southern Isthmus of Rivas is open without forest cover. (Nicaragua Fostestal)

2.12 Highlands and Mining Triangle

The Central Highlands is a triangular shaped region composed of ridges 900- 1,800 m high and covered in mixed forests of oak and pine (Adams 1956). There are only a few major streams, which drain predominantly into the Caribbean (Lange 1984). The Highland area of Siuna–Bonanza–La Rosia is locally referred to as the “Mining Triangle” as it contains economic gold (Figure 2.8), copper and zinc deposits (Adams 1956, Ehrenborg 1996, SallarSs et al. 1999, Cunningham 2000). Recent mapping suggests the region contains mineralized sapprolitic bedrock, with secondary hydrothermally altered and silicified andesitic volcanic rocks and Palaeozoic phyllites (Ehrenborg 1996, Meschede 1998, SallarSs et al. 1999).

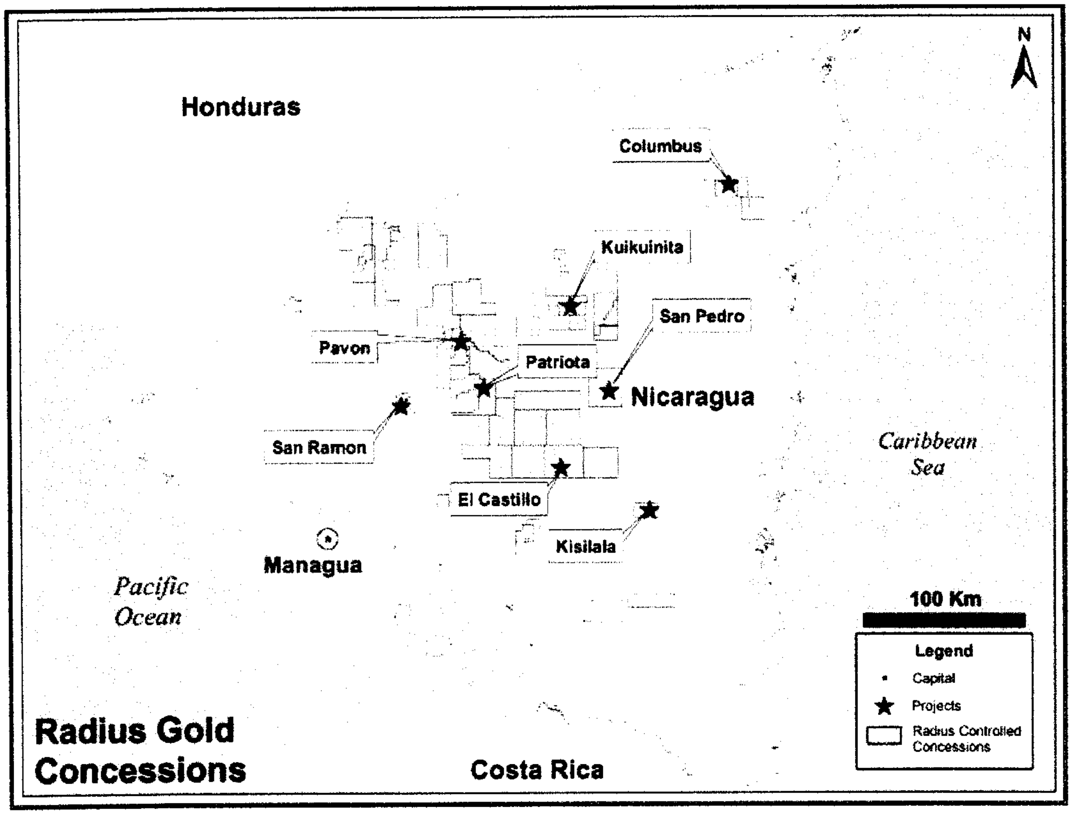


Figure 2.8 Nicaraguan gold deposits. Note their general confinement to the Central Highland region (Radius Gold Inc.)

As the western slopes lie in the rain shadow of the Highlands, sheltered from the humid Easterly Caribbean winds, they remain quite dry through much of the year. This area contains few rivers, which tend to be steep sided, short, and seasonally dry, therefore there is limited agricultural land. The eastern slopes receive the wet Caribbean air and are covered with rain forest, which can support small agricultural fields (Lange 1984, Stone 1984).

2.13 Pacific Coast and the Nicaragua Depression

The Pacific region is bordered by the Pacific Ocean in the west, and in the east Lake Nicaragua separates it from the Caribbean Coast watershed (Healy 1980). The drainage of this 40 km wide area is both to the Pacific and Lake Nicaragua, with the two watersheds separated by a divide reaching 400m above sea level (Ranero et al. 2000). The area is comprised of sedimentary, lacustrine and volcanic soils forming rolling hills and plains (Healy 1980).

Pacific Nicaragua is located within a broad fault-bounded zone, dominated by three stratigraphic groups; the Palaeozoic basement, Cretaceous to Tertiary sediments, and Tertiary to recent volcanic lava and volcaniclastics (Figure 2.6B) (Chan et al. 1999). These rock units are cut by intrusions related to the eastward migration of the Caribbean Plate (Herrstrom et al. 1995). The Cretaceous bedrock is a result of seafloor deposition prior to the closure of the land bridge between North and South America (Healy 1980, Elming & Rasmussen 1997, Lange et al. 1992).

The Nicaraguan depression is an asymmetrical graben, parallel to the Pacific coast, which extends from central Guatemala in the north, SSE to northern Panama in the south (Figure 2.6A). It is located about 200 km from the Middle-American trench. The Nicaraguan depression contains Lake Managua, Lake Nicaragua and most of the volcanoes in Nicaragua (Ehrenborg 1996, Cowan et al. 2002).

There are considerable fluctuations in seasonal rainfall patterns in Pacific Nicaragua, with months without rain during the dry winters, and limited surface water (Healy 1980, Incer 2000). The location of the Isthmus of Rivas and much of the Pacific Coastal region between the Pacific Ocean and Lake Nicaragua or Lake Managua is responsible for the variability of flora. The areas surrounding the lakes are often marshy, with plentiful vegetation on the eastern side (Stone 1966). The vegetation dominating the coastal plain of the Isthmus of Rivas is now a mix of xeno-tropic crops for export, like bananas and coffee, and residual indigenous crops like maize, beans, cacao, and manioc for domestic consumption. There are some remnants of natural forest and savannah (Stone 1966).

2.14 Natural Disasters

The Nicaraguan volcanoes Momotombo, Cerro Negro, Maderas, Concepcion, Masaya and Mombacho have all erupted in historic times (Figure 2.3) (Chan et al. 1999). Eruptions affect a greater area than the immediately vicinity of volcano as ash and tephra can cover large areas or liquefy into a lahar. In some areas, like Villa Tiscapa, ash buried archaeological sites (Lange 1984) and at other archaeological sites, like UNI, Managua, it alternates with cultural deposits (Wyss 1983).

Earthquakes are often associated with volcanic eruptions and the boundaries between tectonic plates (Cowan et al. 2002), Nicaragua is situated in an area where both minor volcanic and larger subduction earthquakes occur (Figure 2.8) (Cowan et al. 2002). The damage sustained in the 1972 earthquake is still visible in the downtown core of Managua. Earthquakes would have affected the prehistoric people of this area.

Hurricanes affect the Atlantic coast of Nicaragua but significant damage has also occurred in the area between Lake Managua and Lake Nicaragua, as well as on the Isthmus of Rivas. Hurricane Juana in 1988 and Mitch in 1998 caused damage estimated at 839 and 1,504 million USD respectively (Figure 2.9) (Lanuza 2003). Equally devastating storms could have occurred in prehistoric times.

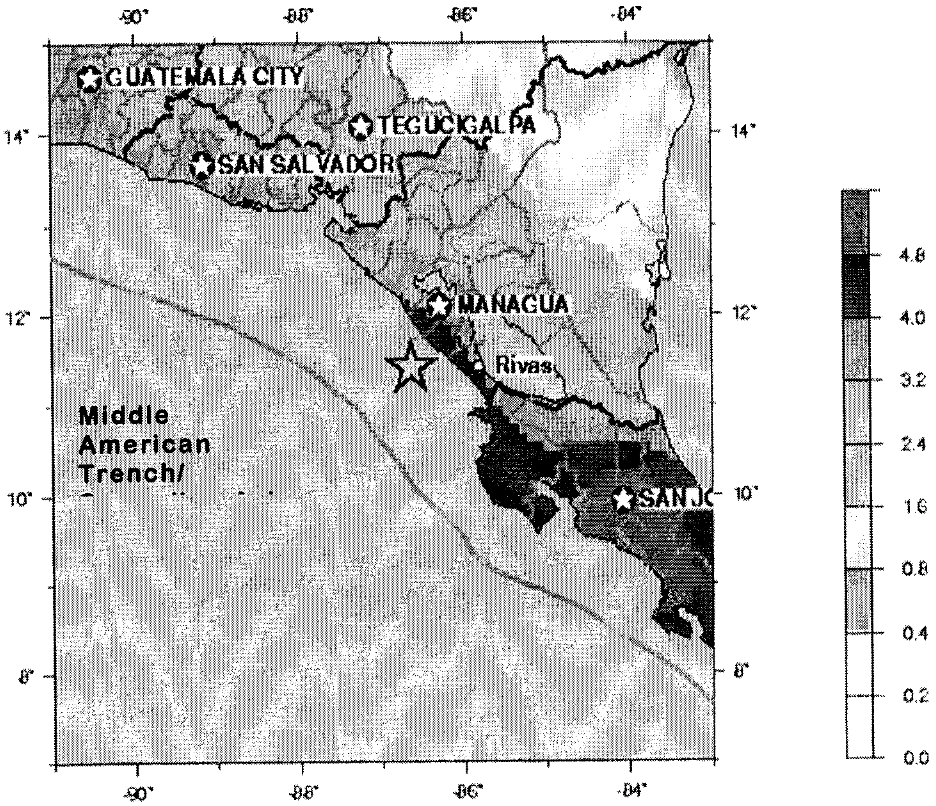


Figure 2.8 Earthquake potential. Higher numbers indicate increased risk. Star is location of 1992 off shore earthquake. (USGS Earthquake Hazard Program)

The Pacific coast of Nicaragua is vulnerable to tsunamis, large waves generated by earthquakes (Ihmle 1996, La Femina et al. 2000). In 1992, 10 m high waves impacted a 220 km stretch of the coast of Nicaragua, followed by higher and more destructive waves. The epicentre of the earthquake was 120 km southwest of Managua and the tsunami arrived 20 min later (Figure 2.8) (Kanamori & Masayuki 1993, La Femina et al. 2000). Local coastal inhabitants barely felt the earthquake and reported that there were no characteristic rumblings and so they did not retreat to higher ground (Ihmle 1996). On August 5, 1854 and February 26, 1902 tsunamis from earthquakes of 7.3 and 7.0 Richter strength impacted the Pacific coast of Middle America, causing an estimated 185 deaths (La Femina et al. 2000).

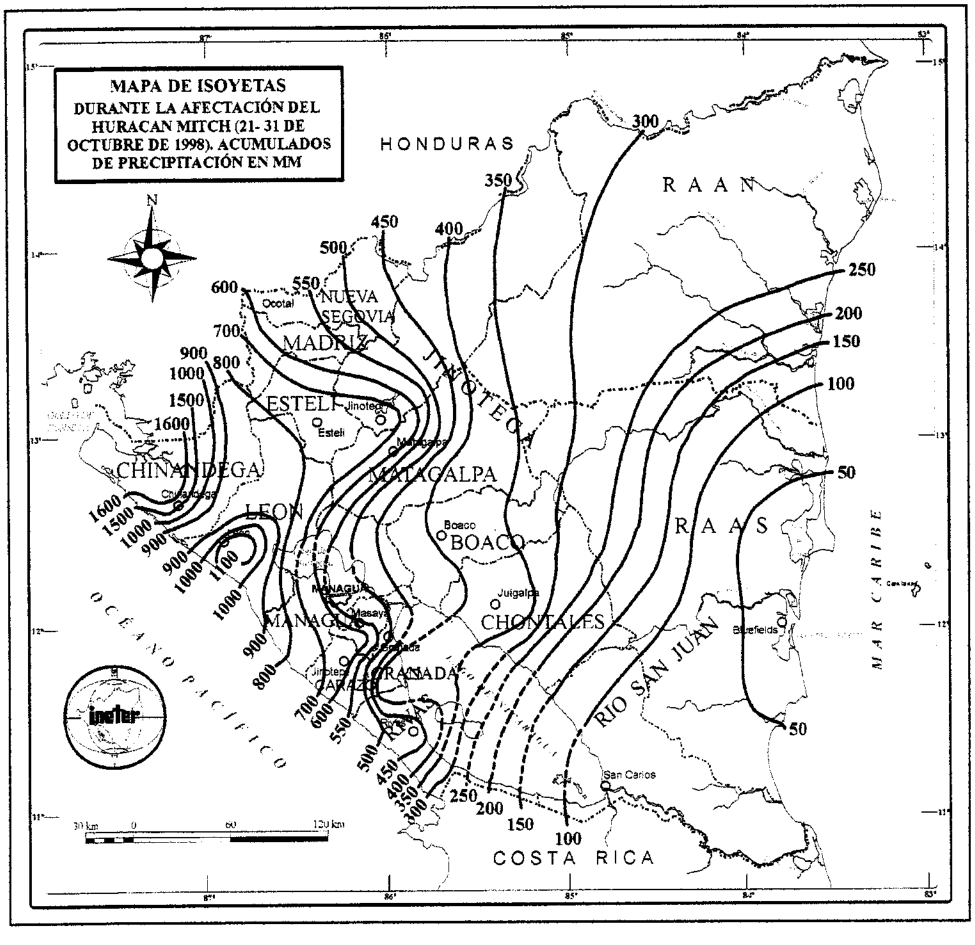


Figure 2.9 Increase in annual precipitation as a result of Hurricane Mitch. (Instituto Nicaragüense de Estudios Territoriales, Meteorologia)

2.2 People of Nicaragua

In pre-colonial Nicaragua, there were two major linguistic groups. One inhabited the Central Highlands and the Pacific coast, and the other the Caribbean lowlands (Figure 2.10). The linguistic group of the Central Highlands and Pacific Nicaragua were culturally and linguistically related to the Aztec and Maya (Robinson 1987, Stone 1966). The Caribbean groups trace their heritage to the present region of Colombia (Floyd 1967).

2.21 Chibcha Groups

Several tribes migrated north from Colombia and settled the Caribbean lowlands of Nicaragua. Since various tribes occupied the area, there were many different dialects but these were all related to Chibcha, which is still spoken in Northern Colombia. These eastern groups practised slash-and-burn agriculture, concentrating on root crops, like cassava (manioc) and plantains. Various fruits were also grown. The Chibcha groups appear to have maintained trade relations with Colombian groups, and Caribbean contact can be seen in similar house structures and canoes, whereas, their food staples show their Colombian heritage. There is little evidence of sustained contact with the western Nahuatl people in western Nicaragua (Floyd 1967).

Most indigenous cultures survived in the east, as the Europeans did not initially settle there. The English did introduce firearms to one group, the Bawihka, in northeast Nicaragua. This group intermarried with runaway slaves, as did many other small eastern tribes, resulting in an Afro-indigenous population. The Bawihka, started taking over adjacent territories, pushing the Sumu and other non Afro-indigenous populations, into the interior and amalgamating other tribes. As a result, Europeans called all the groups occupying the Caribbean lowlands of Nicaragua Miskito, a name for an Afro-indigenous population, despite their different tribal affiliations. Therefore, the historic literature about the Miskito is really a combination of all contacts with eastern groups making details about the different tribes are difficult to extract (Floyd 1967, Keegan 2000).

1a. Mangae 1b. Dirian 1c. Nicoyan 1d. Orotidian
2. Subtiaba 3.Nicarao (Nahuatl) 4a. Corobici (Guatuso)
4b. Rama 5a. Matagalpa 5b. Sumo
5c. Ulua 5d. Mosquito (Miskito) 6a. Voto, Sucre
6b. Guetar 7. Talamancan (Chiriqui) 8. Dorasque
9. Guaymi 10. Cueva (Coiba) 11. Choco

Figure 2.10 Linguistic groups of Central Americas. Note the southern potion of the Isthmus of Rivas is 3. Nicarao (Nahuatl). (Joyce 1918)

2.22 Chontel

The Chontal are linguistically unrelated to the Nicarao and Chorotega of the Pacific coast. They speak a Matagapla dialect (Figure 2.10). The Chontal are a culturally distinct group occupying the marginal area of the western slopes of the highlands. Unlike the two Mesoamerican groups, the Chontal did not live in well-established nation-states and often fought with the two larger groups. This history of frequent violent encounters could be the cause of their banishment to the less productive highlands and their minimal contact with Spanish explorers who had Nicarao and Chorotega guides. The guides used the name Chontal meaning foreigner when the Spanish made contact with the highland people, thus reinforcing the division between the groups (Robinson 1987, Stone 1966, Lange et al. 1992).

2.23 Nahuatl Groups

The Spanish chroniclers recorded the local histories of three different groups of people inhabiting Pacific Nicaragua (Salgado 1996). The Chorotega inhabited most of northwest Costa Rica, Pacific Nicaragua and a zone of the Choluteca province in southern Honduras (Stone 1966, Healy 1984). The Maribios or Subtiaba was a small group in the area around modern Léon (Figure 2.11) (Lange et al. 1992). The final group is the Nicarao, who may have inhabited the site of Santa Isabel at the time of contact (Healy 1984). The Nicarao, like the Chorotega, occupied Pacific Nicaragua, but they were confined to the area between Chinandega and Tipitapa and the Isthmus of Rivas (Figure 2.11) (Stone 1966).

These three groups believed that their ancestors have migrated from Mesoamerica (Healy 1984, Robinson 1987, Lange et al. 1992, Niemel 2000). The Nicarao were the final group to arrive, though according to the Spanish chroniclers, they could not remember when they migrated (Healy 1984, Robinson 1987, Lange et al. 1992). The Nicarao told Bobadilla, a Spanish writer who was collecting their oral traditions, that they originated in a place called Ticomega and Maguatega. There are two towns by the Mexican site of Cholula, near Popocatepetl (Figure 2.4), called Ticoman and Maguatega (Lange et al. 1992). Due to the similarities in the name and some cultural elements, this area is believed to be the origin of the Nicarao (Lange et al. 1992).

The Chorotega and Nicarao occupied the Central Highlands and Pacific Nicaragua. At the time of contact, the Nicarao were in the area between Lake Nicaragua and the Pacific Ocean and the Chorotega were spread throughout the remainder of the western region (Healy 1984, Stone 1966, Lange et al. 1992). These two groups had substantial contact with Spanish conquerors, which caused the almost complete obliteration of indigenous populations by diseases, with the remainder being enslaved. The high rate of intermarriage with the Spanish settlement of the west and highland areas of Nicaragua contributed to the loss of indigenous culture (Healy 1984, Lange et al. 1992, Keegan 2000).

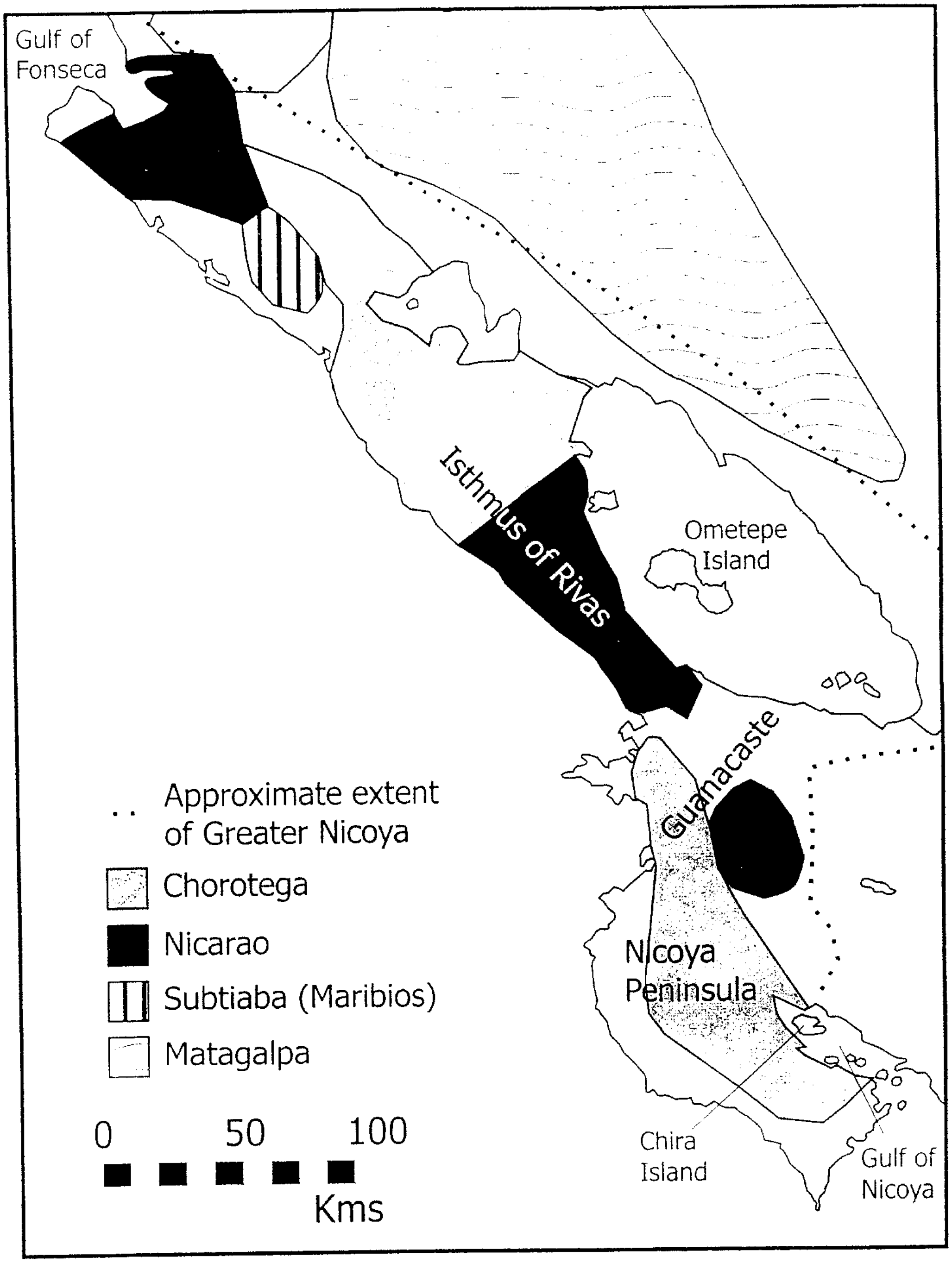


Figure 2.11 Known ethnic groups in Greater Nicoya. (Steinbrenner 2002)

The little oral history that survives in western Nicaragua states that ancestral populations migrated south from Mexico several centuries before the Spanish arrived (Healy 1980, Robinson 1987). Linguistic research supports this tradition, as the people of central and western Nicaragua spoke a dialect of Pipil, which is closely related to Nahuatl, the language of the Aztec people. It is a member of the same linguistic family (Robinson 1987, Lange et al. 1992).

2.231 *Socio-Political Structure*

The Nicarao and Chorotega were divided into three social strata: slave, commoner and noble (Stone 1966, Healy 1980). It is believed that most nobles inherited their elevated status but some societal ranks could be earned. Commoners could rise to a level of nobility by distinguishing themselves in military service. Also, slavery was not a life of inherited servitude, as impoverished commoners could sell themselves or family members in order to pay debts, and slaves could buy their freedom (Healy 1984, Lange et al. 1992, Salgado 1996).

At the top of the hierarchy was the hereditary position of a chief, called the Teyte, who would consult with a council of noble elders, before making decisions. The nobles consisted of smaller local rulers, priests and military captains. Gold smiths were apparently the only craft specialists to be included in this category. The commoner class was a larger group including farmers, craft specialists and all other non-noble free peoples (Lange et al. 1992, Salgado 1996).

2.232 *Economy*

The economic base of the Nicarao was rooted in agricultural production (Healy 1984, Lange et al. 1992, Salgado 1996). The staple crops were very similar to Mesoamerican cultures of the north: maize, beans, chilli peppers, and avocados, with chocolate being drunk at ceremonial occasions (Salgado 1996). Other crops include: cabuya, cotton, maguey, manioc (yucca), and sweet potatoes (Fowler 1989, Lange et al. 1992). The vegetables grown include peppers and calabashes; the fruits cultivated were not limited to jocote, zapote, guava, anoa, and avocado, but these were the most important (Lange et al. 1992). The Nicarao also grew cacao. Fowler (1989) suggested that cacao beans were used in Nicaragua as currency as they were in Mexico during the Classic Period. Mute dogs and turkeys are the only domestic animals recorded (Newson 1987).

The first Spanish explorers in Nicaragua found a well-developed agrarian society in the Central Highlands and Pacific Lowlands. Agricultural land was held communally, and each community had a central marketplace for trading and distributing food (Stone 1966). Goods were also sold at a market, regulated by a supreme authority appointed by the local ruler (Healy 1984, Fowler 1989, Lange et al. 1992).

The indigenous agricultural system was nearly destroyed with the arrival of the Spanish. The population was decimated by massive epidemics of European diseases. The local people were also forced to relocate to work in the gold mines, so that by the end of the 16th century most cultivated land had reverted to jungle (Keen 1992). In the early 17th century cattle rearing with scattered maize and cocoa cultivation started to dominate the landscape (Bailey 1936).

The coffee boom, 1840-1940, caused another change in the agricultural practices of Nicaragua (Anderson 1988, Burns 1991). The commercial coffee industry was driven by the arrival of the Californian gold rush travellers crossing from the Atlantic to the Pacific through Nicaragua. Coffee production requires significant capital and a large labour force. In 1879, laws encouraging foreign investment in Nicaraguan agriculture were passed as a temporary measure to increase coffee production. This arrangement of foreign ownership and local labour created a mono-crop economy, with profits leaving Nicaragua and the economy becoming dependant on the fluctuating coffee industry (Bailey 1936, Bermann 1986, Burns 1991).

After World War II, the Nicaraguan government sought advice on diversification and the focus of agriculture was switched from solely coffee to exportable bananas, cotton and sugar cane. The number of livestock also increased. During this period of time economic growth and industrialization took place. This atmosphere of exponential growth together with the rebuilding of Managua after the 1972 earthquake that destroyed much of the industrial infrastructure, resulted in Nicaragua incurring substantial debts so that by the end of the 1970s, Nicaragua had the highest level of foreign debt in Central America (Bermann 1986).

The Sandinista revolution (1977-1979) was a consequence of a few people, including the Somoza family, owning the majority of the arable land, food processing industry and import/export licences. After the revolution, the restructuring of the agricultural system into smaller family plots removed much of the evidence of the larger colonial system and most of the remaining traces of indigenous cultivation and cultivars (Black 1981, Bermann 1986).

Chapter 3: Literature Review

The recorded history of Central America starts with the arrival of the Spanish, as no indigenous records have survived. The primary sources are Gil Gonzalez Davila (1883), Andrés de Cereceda (1522, 1529) and Gonzalo Fernandez de Oviedo (1529), with Andrés de Cereceda (1522) providing the first account of the people of Pacific Nicaragua. The works of these early writers as well as the first archaeological projects are summarized in several valuable sources. These include Stone (1984), Drennan (1996) and Lange's (1984) article focusing on the archaeology of Greater Nicoya, and the Nicaraguan works of Healy (1980), Gorin (1992), Lange et al. (1992), Salgado (1996) and Steinbrenner (2002).

No written indigenous records have survived, although native pictorials were mentioned in the chronicles. These pictorials are thought to have recorded important events, religious rites and even land boundaries, as they did with other Nahuatl speaking groups. However, there is no surviving evidence of their existence, and no record has been found mentioning either their location or their destruction (Stone 1984, Lange's 1984, Drennan 1996). Therefore, the only accounts of the Nicarao are those of the Spanish, which carry all the problems and inconsistencies of the perspective of an imperial edict.

3.1 Early Research

Archaeological research in Nicaragua and the larger culture area of Greater Nicoya started late in the nineteenth century. The "grandfather" of Lower Central American archaeology was an American journalist and diplomat Ephriam Squier (1852, 1853). He has become known for the first accounts and illustrations of the stone monuments of Zapatera and other islands in Lake Nicaragua though his focus was the proposed inter-oceanic canal (Squier 1852, Squier 1853). Squier's work increased the interest of other explorers and researchers, as did Boyle's (1868) on the Chontales region and adjacent islands of Lake Nicaragua (Figure 3.1).

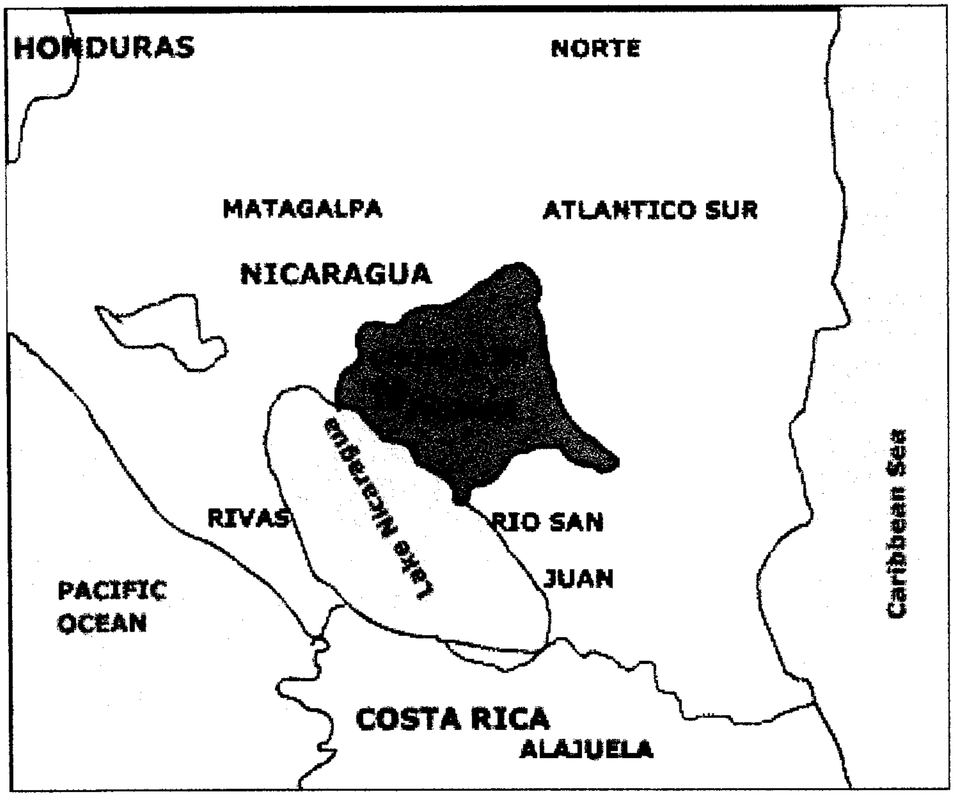
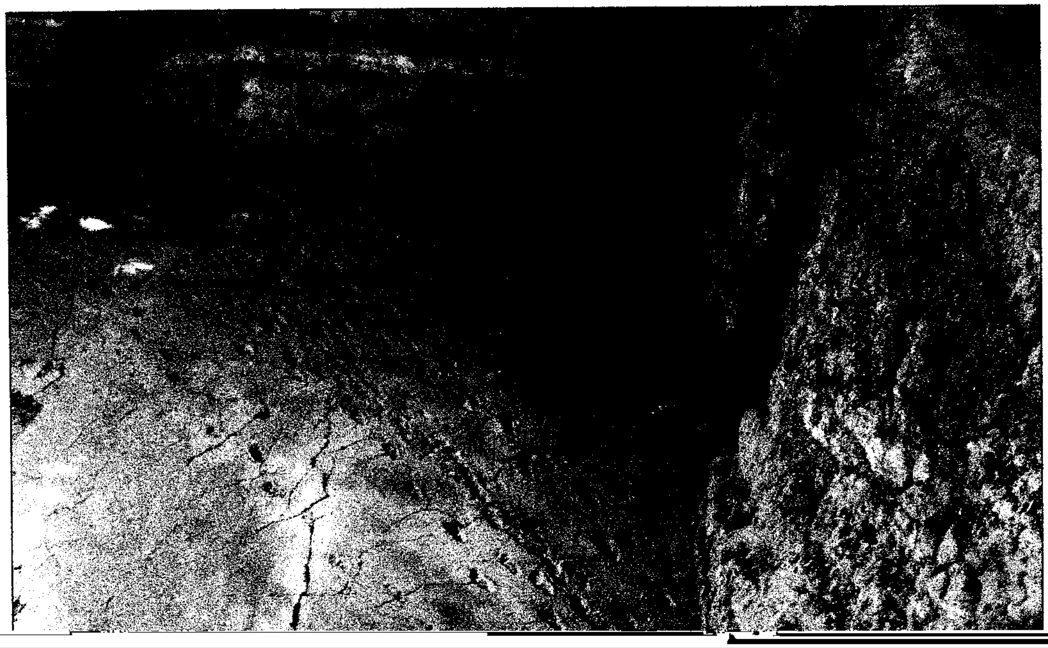


Figure 3.1 Chontales region and capital city. Note: the archaeological region extends north of area marked. (Map 4 Travel ™)

Innovative ideas and excavations were the next step in the archaeological history of the region. In 1868, Boyle's idea that the variations in the stone monuments represented different traditions set the stage for other cultural comparisons that became popular at the turn of the last century. The first excavations were undertaken by an

American Navy doctor, J.F. Bradford (1881). Though his main interest was the inter-oceanic canal, his recording of the provenience of each artefact set an important precedent in Central American archaeology. Bradford (1881) also distinguished several ceramic types and described over 200 vessel burials.

Bradford introduced Dr. Flint of the Peabody Museum to the region during a visit to the Rivas area (Wyss 1983). Flint's major contributions were his identification of Tola pottery and of the similarities of Chorotega and Aztec pottery types (Flint 1884), although he is probably best known as the man who discovered the human footprints at Acahualinca, Managua (Figure 3.2).



At the turn of the century interest in Nicaraguan archaeology waxed and waned. Walter Lehmann (1920) took Bradford's cultural separations further, tracing the intrusions of different groups into the area and sparking academic interest in past migrations into the region. For the first time, the ideas of migration and cultural progression were applied to Greater Nicoya. Lehmann (1920) argued that the Chorotega originated in Chiapas, while Hebert Spinden (1925), working with similar data, tried to prove that they in fact originated in South America (Stone 1984). This debate established the basis of research into ethnic identity, which continues in the region today.

Samuel Lothrop conducted the last major research project before the introduction of modern archaeological techniques. His project concentrated solely on ceramics, a continuing trend in the research of this region. Lothrop (1926) conducted an in-depth study of over 40,000 specimens, from the Greater Nicoya region, with the ceramics coming primarily from American museums and private collections. He compiled a detailed list of pottery types and design motifs, and recorded similarities with known Mesoamerican types. This was published in two volumes entitled *Pottery of Costa Rica and Nicaragua* (1926), which included a summary of conquest ethnohistory. His work was the basis for all subsequent ceramic classifications, and included the belief that Nicarao and Chorotega ceramics are indistinguishable (Wyss 1979, Steinbrenner 2002).

3.2 Modern Research

During the 1950's archaeology began to spread beyond the major cultural areas into the hinterland. This meant that Nicaragua, positioned at the periphery of Mesoamerica, was poised for an influx of scholars. Indeed this can be seen in

Haberland's work. The first name coined for Greater Nicoya, the "intermediate area" by Haberland (1978), was expanded by Willey (1959) to consist of "the land between western Honduras and northern Peru, in effect lower Central America and the Northern Andes".

With a newly defined culture area, international funding institutes increased their relationship with the archaeology of this region. The Peabody Museum project headed by Willey and Norweb (1959 and 1961) investigated several sites in the Rivas area as well as the areas surrounding Granada, Masaya, and Managua. Norweb, following Willey's lead, defined a culture area, Greater Nicoya, which is still used today (Healy 1980). Unfortunately, little of the research conducted by Willey and Norweb was published; it was not until Healy's Peabody-funded thesis (1974, 1980) that the data resurfaced.

Haberland and Schmidt were contemporaneous with Willey and Norweb. They worked with some of the oldest ceramics in the region and identified the Dinarte phase, which dates back to 2000 BC (Lange et al. 1992). Not to miss out on the heated debates dealing with more recent periods, Haberland (1978) suggested that the Nicarao may have migrated into the region as late as 1400 AD as they "exhibited a pure Nahua culture to Oviedo" (Haberland 1978:558). This research, like that of Willey and Norweb, was lost until Healy found unpublished and published reports from many groups of archaeologists (Lange et al. 1992). Other researchers (e.g. Salgado 1996, Niemel et al. 1998) have also tried to find these lost documents with varying degrees of success.

Baudez and Coe started the modern excavations in the region. They conducted a series of stratigraphic excavations on the Nicoya Peninsula (Coe and Baudez 1961, Baudez and Coe 1962, Baudez 1967). This research resulted in the first archaeological sequence for Greater Nicoya, based on radiocarbon and ceramic typologies. The four chronological periods defined by Coe and Baudez (1961) were: Zoned Bichrome Period (1-300 AD), Early Polychrome Period (300-750 AD), Middle Polychrome Period (750-1000 AD), and Late Polychrome Period (1000 AD -Conquest) (Snarskis 1981). These four periods remained in use, with minor changes, until the early 1990's (Steinbrenner 2002). The four periods roughly correspond to the Mayan periods of Late Formative, Early-Late Classic, Late-Classic-Early Postclassic, and Late Postclassic. The influence of Coe and Baudez can still be seen in modern archaeology even though their chronology has been replaced. They believed that cultural elements in the intermediate area could be explained by influences from the stronger cultures north and south of the region (Baudez and Coe 1962). In fact, modern researchers are still looking at these regions to explain observed changes in the material culture of Greater Nicoya.

Frederick Lange (1971) was the first processual archaeologist to work in Greater Nicoya. He worked in the Sapóa Valley of Costa Rica, which is near the Nicaraguan border. Lange has amassed a great deal of influence over the past and present archaeology of the region, as his extensive list of publications can attest. Initially he focused on settlement patterns and the role of Guanacaste in mediating northern and southern influences. He compared cultural adaptations in different locations along the Pacific coast. Later, Lange conducted research in Nicaragua and was pivotal in the refining of Greater Nicoya's ceramic chronologies. He also questioned the importance of Mesoamerican influence instead of championing the idea that the region should be viewed as a frontier-buffer zone (Lange 1978, Lange et al. 1984, Bonilla et al. 1990).

Paul Healy, who never excavated in the country, conducted Nicaragua's most important archaeological work of the 1970s. His book the "Archaeology of the Rivas Region, Nicaragua" (1980), is a study of materials excavated by the Peabody archaeological project of Willey and Norweb in 1959 and 1960. The catalogue of ceramic types for the Zoned Bichrome, Early Polychrome, Middle Polychrome and Late Polychrome that Healy developed for his 1974 doctoral thesis is the standard chronology that is still used, with minor revisions. These ceramic chronologies have considerable similarities to those constructed by Baudez (1967) for Tempisque, Costa Rica.

Healy and Lange disagree about the extent of Mesoamerican influence. Healy, using Nicaraguan data, theorized that even the earliest cultures in the Rivas area are Mesoamerican (1980). Lange, using mostly Costa Rican data, believes the area is a combination of external forces and local traditions (1978). Healy uses ceramic types with "Mixtec incersarios", similarities in utilitarian wares, figurines, design motifs and the use of molluscs as evidence of this Mesoamerican connection (1980). This rationale resulted in Healy and many others believing that a line might well be drawn just south of Rivas, to mark the extent of the Mesoamerican culture area (1980).

The 1980's saw several archaeological projects, but information about these is difficult to obtain as large quantities of research undertaken during the first years of Sandinista rule are missing or were destroyed. These projects included the excavations at San Cristóbal by Wyss (1983), Lange and Sheets' surface survey (1983) and Baker and Smith's survey of Zapatera Island (1987). Overseas interest also increased at this time. French archaeologists Rigat and Rivas (1996) surveyed the Chontales region between

1985 and 1987. Japanese archaeologists are also reported to have worked in the region at this time, though no details about their work are available (Lange et al. 1992).

Several of the archaeological projects conducted in the 1980s were not published until well into the next decade. The first archaeological project to include lithic analysis in its research design was Lange and Sheets' 1983 surface survey of 26 sites across the entire country of Nicaragua. This research was conducted to establish the geographical distribution of diagnostic cultural materials, including settlement patterns, ceramic types and lithic technologies (Lange et al. 1992:35). However, the final publication consisted of a chronology similar to the one already derived for ceramics, a brief mention of settlement patterns but little on lithic diagnostics.

When viewing the whole region, the history of lithic research emerges. Prior to the 1970s, the majority of lithic analyses consisted of chronology and simple descriptions. In the 1980s, lithic research increased in the Mesoamerican culture area, Panama and parts of Costa Rica. Presently, archaeologists in these regions are actively seeking material sources, describing debitage sequences, microwear and behavioural aspects in lithic analysis (Acuña 1985, Braswell 1994, Cackler et al. 1999, Berman et al. 1999, Valerio & Salgado 2000). There is a noticeable gap in Central American lithic research in Nicaragua. While adjacent areas were diversifying their study of lithics, Nicaraguan archaeologists were surviving political unrest and refocusing on ceramic typologies. Present archaeological research still focuses on descriptions and very few research projects include lithics in their research design.

The most recent research has focused on the relationship between Greater Nicoya and Mesoamerica. Examples of this research on Nicaraguan prehistoric migration include

Fowler (1981,1989), Day (1984), and Hoopes and McCafferty (1989). Day argued that iconography on pottery is related to Central Mexican Postclassic wares and serves as evidence of its arrival with the Nicarao or Chorotega (1984). This idea was challenged by Hoopes and McCafferty (1989), who felt that there were new stylistic elements on ceramics around 800 AD more closely related to Gulf Coast People than Central Mexican and concluded, as did Fowler (1981,1989), that the Nicarao and Chorotega are connected with the Olmeca. Other important works include Lange (1992) *Wealth and Hierarchy in the Intermediate area*, which was based on the 1987 symposium dealing with the historical "shortcomings" of the area. Other general works from this period include *Reinterpreting Prehistory of Central America* by Graham (1993), which does not focus on Greater Nicoya, but still provides an interesting insight into the larger region.

The A*rchaeology of Pacific Nicaragua* (Lange et al. 1992), reports Lange and Sheet's (1983) survey and Haberland's (1960) Ometepe Island work. This book also includes the first discussion of obsidian artefacts from Nicaragua and incorporated descriptions and source allocations. Well-known quarries in Honduras and Guatemala were determined to be the obsidian sources using visual examination. The report also stated that no local materials were utilised (Lange et al. 1992).

30 Ãnos de Arqueologia en Nicaragua (Arellano 1993) is a collection of different articles that had never been published, but were collected and stored at the National Museum in Managua. The Costa Rican Journal *Vinculos,* published by the National Museum in San Jose, is a reservoir of information about the region's archaeology. A special *Vinculos* edition titled *Taller sober el futuro de las investigaciones arqueologicas y etnohisóricas en Gran Nicoya* (Vázquez 1994) and P*aths to Central American*

Prehistory (Lange 1996) are two important volumes about the current state of Central American archaeology.

A conference held in Guanacaste in 1993 introduced a new chronological sequence, whereby the Zoned Bichrome and Early/Middle/Late Polychrome periods were replaced with Orosí (1000-500 BC), Tempisque (500 BC-300 AD), Bagaces (300-800 AD), Sapoa (800-1350 AD) and Ometepe period (1350-1550 AD), (Guerrero et al. 1994). This change in chronology began in Costa Rica when recent research pushed the date of The Early Polychrome Period back to 300 AD. More recent research has moved the Orosí period back to 2000 BC (Niemel 2000).

In the 1990's, a survey of the Lake Managua basin pushed the boundaries of Greater Nicoya north into these areas (Rigat & Rivas 1996). Other areas surveyed in Nicaragua include Chontales by Nicaraguan archaeologists (Figure 3.1), the area around the Honduran border by Fletcher et al. (1994) and Matagapla by Van Broekhoven (2002). Fletcher's et al.(1994) enthnohistoric survey is an example of the typical research now being conducted in the region. Fletcher et al. (1994) located over 90 sites and classified them based on the amount of Honduran or Nicaraguan characteristics. The ethnic identity of past populations is a strong undercurrent in recent research, with many people trying to draw new boundaries between culture areas.

In the mid 1990s Lange returned to Managua and surveyed a large area under the threat of development. Besides the information generated by the survey, his on-going work to publish hard-to-find Nicaraguan archaeological texts, in print as well as on the internet, would have been an important contribution to the region. However, only the first two years of his survey have appeared in print and the internet site was never completed

(Lange 1995,1996). He also described the largest collection of funerary urns ever collected and analysed scientifically as well as establishing a new local chronology.

Silvia Salgado (1996) conducted another important survey during the mid-1990s, in the Granada area. Her survey documents 37 sites, some previously noted by Norweb, as well as new sites. Two sites surveyed by Salgado included Tepetate and Ayala that date from 950 AD to contact and are thought to be Chorotegan sites. In Tepetate, fourteen low mounds that were covered by stone slabs were discovered, as well as a stone plaza (Salgado 1996). These are rare in Nicaragua. The site of Tepetate had a large number of lithic artefacts, including their provenience; a step usually overlooked in Nicaraguan archaeology. Salgado's thesis (1996) focused on the site of Ayala and the ceramic production from Tepetate. Counts of lithic artefact were the only information obtained.

Besides the important information about ceramic production, Salgado (1996) presented the argument that major changes at the end of the Bagaces period were connected to the migration of Mesoamerican groups into the area. She used the presence of obsidian artefacts at Ayala as evidence of Honduran and Mesoamerican connections. The obsidian was visually sourced, with the majority from Güinope, across the border in Honduras, 15% from Ixtepeque and El Chayal in Guatemala and trace amounts from Zacualtipán in Hidalgo (Salgado 1996). However, the artefacts from Ayala were analysed briefly, resulting only in counts. Additionally, only pieces over 4 cm long received even this level of analysis (Braswell 1994, Salgado 1996).

In 1999, Karen Niemel conducted an archaeological survey of the area comprising the department of Rivas. Niemel employed a similar methodology to Salgado focusing on the emergence of social complexity at prehistoric sites. She found evidence of migration and exchange patterns and described the transition between the Bagaces and Sapoá periods (Niemel 2000). This survey covered an area of 264 km^2 ranging from just south of the town of Rivas, north to the Río Ochomogo, including the site of Santa Isabel (Niemel 2000).

Santa Isabel, which was the largest of four sites that were further examined with shovel test pits by Niemel's team, contained the most mounds (Niemel 2000). The only mention of lithics was the visual identification of obsidian artefacts as coming from Ixtepeque and Güinope (Niemel 2000). Niemel's analysis of the ceramics suggested that Greater Nicoya did not form a homogenous society before the Mesoamericans arrived and that ethnic boundaries between the Nicarao and Chorotega may explain site location changes at a later period (Niemel 2000). Presently, the work at Santa Isabel by the University of Calgary has resulted in the identification of new pottery types, a correlation between ceramic form and style, and the identification of the raspaditas.

The Santa Isabel archaeological site was first dated to the Ometepe period (1350-1550 AD), based on diagnostic ceramics (Healy 1980, Flowler 1989, Steinbrenner 2002, Niemel 2002, McCafferty et al. 2003). However, twelve recent radiocarbon dates (890-1280 AD) from the site places it in the older Sapoa period (800-1350 AD) (McCafferty & Steinbrenner 2005). There are problems caused by these new dates. According to ethnographic sources and the established chronology, the Ometepe period started with the arrival of the Nicarao and the introduction of Ometepe diagnostic ceramics. This becomes an issue when the diagnostics appear to be some 500 years older. If "pots equal people" then the Nicarao arrived and founded Santa Isabel 500 years earlier. However, if "pots are not people", a more widely accepted idea, then Santa Isabel was inhabited by another group of people. In this study, the ethnographic accounts showing the people of Santa Isabel to be Nicarao who used Ometepe type ceramics are accepted and for consistency and clarity, dates are given as absolute values and not in periods defined by ceramics.

The references in this chapter include all known published and unpublished work. There is no way of knowing the true extent of the lost research, nor can we be sure that all articles and site reports have been retrieved from the Nicaraguan National Archives. What is clear is the extreme lack of lithic information available for Nicaragua. The current trend in Nicaraguan research is that of ethnic identity and migrations. It will be interesting to see how lithic analysis, with its many ethnic facets, features in future projects.

3.3 Lithic Analysis

William Henry Homes (1894) conducted one of the first systematic studies of lithic artefacts. It was his intention to use the tools as chronological markers, to understand the evolution of form and function and to understand the processes of use and production (Andrefsky 1995). These are the same issues presently studied in lithic analysis. Much of the past and present lithic research is based on the guidelines created by Homes over a hundred years ago. Replication was a significant development in lithic analysis. François Bordes and Don Crabtree started reproducing stone tools in the 1950s and 1960s. Their account of the reduction sequences could be applied to refitting analyses (Andrefsky 1995).

In the 1930s, the Russian scientist Sergei Semenov started using optical microscopy to look at stone tool edges (Levitt 1979). However, the western world was unaware of his work until 1964 when it was translated into English with the title "Prehistoric Technology" (Semenov 1964). Semenov pointed out that overall tool morphology does not always coincide with function, an important step in the evolution of lithic analysis. His research also showed that it was possible to conduct functional analysis of stone tools, by examining the use edges with a microscope (Andrefsky 1995).

George Frison (1968) was the first known researcher to describe the changes in shape of stone tools through their use life. This premise had far reaching effects as tool morphologies were used as topologies, but if the shape of the tool changes throughout its use life, then the topologies must be equally adaptable. This revelation changed the way researchers viewed their artefacts, lithic tools were no longer 'carved in stone', they were dynamic elements of human culture (Keeley 1980).

3.31 Usewear

Microwear or usewear analysis basically attempts to determine function through examination of the wear patterns on a tool's surface (Andrefsky 1995). Semenov's research in 1964 started this branch of lithic analysis. Before this, attempts to determine lithic tool functions were directed at the use edge without the aid of magnification. After Semenov's research was published in English in 1964, a large number of articles surfaced using different methods and techniques. It was not long before articles outlining the "proper" technique appeared (MacDonald and Sanger 1968, Gould et al. 1971, Hayden and Kamminga 1973, Keeley 1974, Tringham et al. 1974, Odell 1977, Ahler 1989).

In 1979, the papers presented during the first conference on lithic usewear were published (Hayden 1979). This volume was of great importance as it covered a variety of topics including polish and striations, tool function, fracture mechanics, variability in raw materials, methodology and theoretical applications. Since then, other topics frequently appearing in the literature include the use of scanning electron microscopy (SEM), tool hafting, prehistoric subsistence, specialization and ceremonial functions (Anderson 1980, Meeks et al. 1982, Keeley 1982, Mansur-Franchomme 1983, Yerkes 1983, Anderson-Gerfaud 1988, Knutsson 1988, Shea 1988, Juel Jensen 1989, Sievert 1992, Pope 1994, Bienenfeld 1995, Odell 2004).

There are two general types of microwear microscopic analysis, those that use high power magnification and those that use low power magnification. Keeley's work (1980) is a good example of the typical high power approach (200x or more) as he examined micropolishes and striations. The low power approach is closely associated with the work of Odell among others (Odell 1981, Tringham et al. 1974) and concentrates on microchipping and edge rounding. The three doctoral dissertations, of Lawrence Keeley (1977), George Odell (1977) and Johan Kamminga (1978), dealt with microwear and presented three different approaches to usewear analysis. Keeley (1977) found high power microwear analysis was most effective for a British Palaeolithic assemblage. Odell (1977) used low power microscopy to study lithics from a Dutch multi-component site. Kamminga (1978) looked at a set of ethnographic tools from Australia and used microwear analysis to recognise functional differences on aboriginal stone tools with verified functions (Olaussen 1978, Keeley 1980, Olausson 1980, Vaughan 1985, Sussman 1988).

It has now become apparent that the two types of micro-wear analyses have different abilities to identify use. Low-power microscopy is a useful technique for the analysis of function but is not able to determine material worked by the tool (Odell 1981, Sussman 1988). High-power microscopy using polish development has been shown effective in determining the material worked. Although high-power analysis is not always accurate when dealing with an individual tool, or a tool used on more than one material, it does provide a statistically sound determination of the material type worked for a tool class. Also, the high power approach appears to be of limited value when dealing with coarse-grained materials, since their microtopography hinders the formation of polishes and striations (Olausson 1980, Moss 1983, Richards 1988, Sussman 1988). The higher cost of high power analysis and small sample size can be additional problems with the approach (Dumont 1982, Grace et al. 1987, Grace 1989).

Recently, researchers have started using scanning electron microscopy (SEM) for microwear analyses (Knutsson 1985). The benefits of SEM include its high magnification capabilities and the wide range of magnification available, allowing both low and high power studies. This is a great advantage when only a few lithics are available for analysis. The cost of SEM has decreased in recent years and it has become more accessible. The size of the vacuum chamber within the SEM dictates the maximum size and the orientation of the sample.

The next development in the study of microwear was an awareness of secondary characteristics, which affect the edge morphology and usewear. These factors include post-depositional factors, raw material type, force exerted during use and length of use (Odell 1981, Moss 1983, Vaughan 1985, Akoshima 1987). There are several mechanisms that can cause edge damage after the end of archaeological use. There have been several trampling experiments, as well as those looking at damage cause by excavation and curation (Levi-Sala 1986). Researchers must now demonstrate that only use factors are responsible for the usewear patterning observed.

Classes of tools or tool groups can be defined functionally only when data from many samples are examined and other factors eliminated. Experiments that vary the length and pressure of use with those of post-depositional factors are attempts to eliminate non-function factors in edge wear creation. These are generally grouped under use-related factors and condensed into modes of action, containing the length of time, the force of use and hardness of the material the tools were used on (Speth 1975, Olaussen 1978, Flenniken & Raymond 1986, Frison 1989, Cotterell & Kamminga 1990).

Recent usewear studies have involved the quantification of microwear, where the goal is to create a standardized terminology, including typologies, petrography, attributes, and technology, as well as the creation of standard microwear patterns for a multitude of functions for faster analysis (Luedtke 1992). Although this need was recognized in the 1970s and 80s, some individuals are still using their own terminology (Hayden 1979) and lithicists are still sceptical of the findings of any analysis that does not include replication data.

There have been a many recent publications involving the quantification of microwear (e.g. Hayden 1977, Keeley 1980, Odell 2004, Rots & Vermeersch 2004); Table 3.1 shows the expected usewear emerging from these studies. This chart uses data from both low and high power studies in a multidimensional approach.

Use/ Material	Bore	Cut	Chop / adze	Scrape	Saw	Wedge	Whittle	Haft	Summary
Wood	Pl, Pt Spl, Spt, Csv, Csd, Chv, Chd	Pl, Pt, Stl, Stt, Ctv, Ctd	Pl, Prt, Sdt, Stt, C½mt	Pl, Prt, Sdl, Sdrt, Csd	Pl, Pt, Spt, Spl, C½mt, C½ml,	Pl, Pt, Sdl, Sdt, C½ ml, C½ mt Ctv, Ctd	Pl, Sdl, Sdt, Cdt	Prv, Prd, Spl, Spt, Rv, Rd	P, (min S) F
Bone	Pl, Pt Spl, Spt, Csv, Csd, Chv, Chd		Pl, Prt, Csv, Csd	Pl, Prt, Sdl, Sdrt,	Pl, Pt, Spt, Spl, Cbl, Cbt	Pl, Pt, Sdl, Sdt, C½ ml, C½ mt	Pl, Sdl, Cht, Cst	Prv, Prd, Rv, Rd	R (edge) Pb, L, S
Hide		Spl, Spt, Csv, Csd, Ced, Cev		Pl, Prt, Sdl, Sdrt,					P (dull, spotty), S, L
Meat		Pl, Pt, Stl, Stt, Ced, Cev, Csd							P (dull), L
Antler	Pl, Pt Spl, Spt, Csv, Csd, Chv, Chd			Pl, Prt, Sdl, Sdrt, Csl	Pl, Pt, Spt, Spl, C½mt, C½ml,	Pl, Pt, Ctv, Ctd Cst, Csl	Pl, Pt, Cst	Prv, Prd, S(random) Rv, Rd	S (rare)
Plant		Po, Pl, Pt, Prl, Prt, Pb, Stl, Stt,	Po	Po, Pl, Prt, Sdl					Pb(strong) S, Po
Summary	R, P, Cdl, Cdt, Csv, Csd, Chv, Chd	P (gapped) Ctv, Ctd	Csl, Cst	P, Sdl, Sdt, Cdt, R	Ctv, Ctd, R (light)	P, Csl, Cst, C½ ml, C½ mt	P, Cdt, Cht, Cst	Pb (spot) Prv, Prd, Rv, Rd S(random)	

Cbl: Microchipping big on leading edge
Cdd: Microchipping perpendicular to dorsal edge
Cdt: Microchipping perpendicular on trailing edge
Cev: Microchipping deep on ventral surface
Chv: Microchipping shallow on ventral surface
C½mt: Microchipping in ½ moon shape trailing
Csl: Microchipping stepped on leading edge
Csv: Microchipping stepped on ventral surface
Ctv: Microchipping transverse to ventral edge
L: Lump/ undulating surface
Pb: Bright polish
Po: Polish domes (glassy masses)
Prt: Ridge polish on trailing edge
Pt: Polish on trailing edge
Rd: Rounding of high areas on dorsal surface
S: Striations
Sdrt: Striations perpendicular on ridge trailing
Spl: Striations parallel to leading edge
Stl: Striations transverse to leading edge

Cbt: Microchipping big on trailing edge
Cdl: Microchipping perpendicular on leading edge
Ced: Microchipping deep on dorsal surface
Chd: Microchipping shallow on dorsal surface
C½ml: Microchipping in ½ moon shape leading
Csd: Microchipping stepped on dorsal surface
Cst: Microchipping stepped on trailing surface
Ctd: Microchipping transverse to dorsal edge
F: Flatten surface
P: Polish
Pl: Polish on leading edge
Prd: Ridge polish on dorsal surface
Prv: Ridge polish on ventral surface
R: Rounding
Rv: Rounding of high areas on ventral surface
Sdl: Striations perpendicular to leading edge
Sdt: Striations perpendicular to trailing edge
Spt: Striations parallel to trailing edge
Stt: Striations transverse to trailing edge

Table 3.1 Observed experimental usewear. (Keeley and Newcomer 1977, Keeley 1980, Odell and Odell-Vereeken 1981, Gendel and Pirnay 1982, Salls 1985, Newcomer et al. 1986, Unrath et al. 1986, Driskell 1986 and Grace et al. 1988, Kooyman 2000, Odell 2004, Rots & Vermeersch 2004).

Variation in the results of the larger microwear studies is explained by differences in material worked, rock type, duration or pressure of use or definition by the lithicist. Therefore, only the microwear correlating between two or more authors was included in Table 3.1. Gaps show that some tasks were not performed using certain materials. There is some overlap, as a result of limited microwear possibilities, as well as materials of similar hardness produce similar wear patterns (Table 3.2).

A number of blind tests in the late 1970s and 80s used high power microscopy (Table 3.3) (Keeley and Newcomer 1977, Keeley 1980, Odell & Odell-Vereeken 1981, Gendel and Pirnay 1982, Grace et al. 1983, Newcomer et al. 1986, Unrath et al. 1986, Driskell 1986). The blind tests were able to identify the location and mode of use, but could not recognize the material worked. Researchers now confirm their functional interpretations with secondary evidence, such as residues. Odell (2004) and other researchers advocate a combination of end angles, tool form, low and high power microscopy, residues, ethnohistories and other types of data in the interpretation of function (Grace et al. 1983, Vaughan 1985, Newcomer et al. 1986, Andrefsky 1998, Kooyman 2000 etc.). Use locale, mode and material can now be determined with a reasonable amount of certainty at the collection level. Several blind experimental microwear studies have tested the validity of use locale, use mode and worked material determination, with promising success (Table 3.3).

Hardness	**Materials**
Hard	Dry antler, bone, dry wood
Medium-hard	Fresh hard woods, fresh antler
Medium-soft	Soft woods, dry hide, reeds, grasses, fibrous plants, plants with silica
Soft	Meat, fresh hides, green plants, soft plants, non-fibrous plants

Table 3.2 Hardness of Materials. Note: some researchers have 3 categories, but this is the most common division. (Odell & Odell-Vereecken 1981)

	Use area		Motion		Worked material	
Keeley (1980)	14/16	87%	12/16	75%	7/16	44%
Newcomer et al. (1986)	32/50	64%	18/50	36%	3/50	6%
Unrath et al. (1986)	87/120	72%	62/120	52%	31/120	26%
Grace et al. (1983)	79/80	99%	72/80	90%	40/80	50%
Average		*80.5%*		*63.25%*		*31.5%*

Table 3.3 Microwear blind test results. Note fractions are number of correct responses to total trials. Percents are the success rates.

3.32 Lithic Residue Analysis

Recently, researchers have begun to examine both archaic and experimental residues on lithic tools. According to Jahren et al. (1997) the presence of residues adhering to tool surfaces provides information about the use of the tool and past environments. Lithic residue analysis in the late 1960s and early 1970s was related to immunological research and blood type determinations. After the research of Loy (1983) on haemoglobin recrystallization, the area of residue analysis began to be recognized by archaeologists. Loy focused on the identification of different blood residues (Loy & Hardy 1992), but also included the recovery and microscopic identification of animal fibres and collagen fibres (Briurer 1976, Broderick 1979, Shafer & Holloway 1979, Fullagar et al. 1998).

After the initial inclusion and study in the 1980s of plant residues, the new techniques concentrated on animals. Plant residues were noted during the early residue studies but little research was aimed at their recovery. Plant fibres and cells, starch grains, and phytoliths have been identified microscopically from stone tools (Shafer & Holloway 1979, Loy et al. 1992). Anderson (1980) and Mansur-Franchomme (1983) claimed to have found phytoliths and other plant residues embedded in use polish on lithic tools, but these small fragments could just have been part of the lithic tool (Unger-Hamilton 1984).

During the late 1980's and early 1990's, residue analysis was hotly debated. Ironically, the technique that started modern residue studies, haemoglobin recrystallization and other blood residue research was questioned. This re-examination was the impetus for several large studies including experiments to test the preservation of biological cells and fibres. This period also saw an expansion of the analytical techniques available. Traditionally, most residues were identified through chemical and immununochemical characterization, such as chromatography (Loy & Hardy 1992, Jahren et al. 1997). An immunological antigen-antibody reaction has tried to address the criticisms of blood identification (Cattaneo et al. 1993, Downs & Lowenstein 1995, Tuross et al. 1996). In this test, the reaction of an unknown residue with a number of antibodies extracted from different animals was observed. If the residue reacted to a specific antibody, the host would be present in the residue on the tool. This technique had little success with plant residues and even blood residues identified in this manner have been questioned (Cannon 1995, Hortola 2002).

There have been many refinements to these methods as well the development of similar techniques including crossover immunoelectrophoresis (CIEP), enzyme-linked immunosorbant (ELISA) and radioimmune assay (RIA) (Newman 1990, Kooyman et al. 1992). CIEP uses an antigen-antibody immune reaction, similar to that used in forensic medicine and as in the earlier antigen-antibody test, a reaction indicates the species in the sample (Cannon 1995). Cannon has had some success using this technique in Yellowstone National Park, with coarse-grained material and large well-persevered samples. ELISA is a quantitative analysis that involves linking a specific antibody or antigen to a microtitratron plate. This attachment allows the introduction of sample to distinct locations. A second enzyme antibody is added and an oxidation reaction produces a colour that is proportional to the amount of antigen present in the sample. The RIA method is similar to ELISA except that it uses radioisotopes instead of enzyme antibodies to detect the antigen complex. It is more sensitive than CIEP. The debate over the validity of techniques remains a dominant topic in residue research.

Chapter 4: Theory

The fascination with food and eating by anthropologists started in the nineteenth century with Garrick Mallery and William Robertson Smith (Gilbert & Mielke 1985). Food studies have illuminated broad societal processes such as political-economic value-creation, symbolic value-creation, and the social construction of memory. There are several subsections within the classic food ethnographies: food and social change, food insecurity, eating and ritual, single commodities and substances, eating and identities, and instructional materials. The most extensive anthropological work among these subtopics has focused on food insecurity, eating and ritual, and eating and identities (Gilbert & Mielke 1985, Dietler & Hayden 2001, Dalby 2002).

4.1 History of Food Studies

Food has always played a role in anthropological studies, but until recently simply supplied background information to academic inquiries. Food and the diet of a culture entered into anthropology in the 1900s, when lists of foods, or food combinations, were published without additional analysis. Even anthropologists working in the field would only record the plants collected, without the reasons for their selection (Gilbert & Mielke 1985).

A scientific approach to food anthropology began in the 1950s. During the next two decades, anthropologists focused on two aspects of food theory. Nutritional studies, with anthropologists analysing the nutritional value of a group's diet, often encountering stumbling blocks, as the anthropologists were rarely trained as nutritionists (Counihan 1999, Dalby 2002). A second direction of study was the origins of domestication. This focused on only a few select foods, which were assumed to be most influential for cultural evolution. This caused a search for the oldest plant remains and regional competition for the origin of a particular domesticate, resulting in a multitude of social and biological theories, to explain the transition to and diffusion of agriculture (Counihan 1999, Dietler & Hayden 2001, Dalby 2002).

Anthropologists in the 1970s and 1980s became disillusioned with science, due to their inability to construct effective laws about human behaviour and to explain counter-intuitive choices of people (Dietler & Hayden 2001). This dissatisfaction spread to the food anthropologists, who were beginning to understand that food had an important social role and constituted different roles in individual cultures. It was during this paradigm shift that anthropologists started to view food in its symbolic role within societies. A particular food or ritual was then assessed within the context of the culture (Counihan 1999, Dietler & Hayden 2001).

In the 1980s and 1990s, food anthropology followed a slightly different direction to other anthropological sub-disciplines. While anthropology and archaeology especially returned to the scientific method with processual archaeology, food anthropology turned to other social science fields for inspiration. The disciplines of economics and politics supplied the background for the conceptualization of food, food production and food ritual. This approach caused the anthropologists to look beyond the simple cultural significances, to the political and economic circumstances that produced that symbolism (Dietler & Hayden 2001, Dalby 2002).

The start of the 21st century has seen a growth in food anthropology research that resembles the increase of the 1970s and 1980s, but with diversified topics and theoretical approaches, such as bioengineering, genetically modified foods, migration issues and ethnic identity. All these issues emphasize the cultural and social aspects of food production, consumption and the food itself, stepping away from former nutritional, and economic research (Dietler & Hayden 2001, Dalby 2002).

4.2 A Social-Psychological Approach: Social Identity Theory

Before the ethnic implications of food can be discussed, the ethnic group must be understood. Social identity theory is systematic analysis of the different psychological processes involved in the creation and the dynamics of social groups. This analysis can be considered an elaboration of the social-psychological foundation of ethnicity (Roosens 1994). Social identity theory also elaborates on the implications of group membership for inter-group relations. This is in contrast to the anthropological approach, which uses only observations to formulate social theory (Dietler & Hayden 2001).

According to Roosens (1982), an ethnic group is created and maintained when a social group draws a dividing line between itself and other groups by means of cultural emblems and values. The amount of separation of the group differs according to the people involved and the surrounding groups. This definition is similar to the group definition used in recent social-psychological research on group phenomena. Brown (1988) using the work of Tajfel (1978, 1981) and Turner (1981, 1982), developed the following definition:

> "A group exists when two or more people define themselves as members of it and when its existence is recognized by at least one other. The 'other' in this context is some person or group of people who do not so define themselves."

In other words, a group is a social-psychological reality when a number of people share the perception that some of them belong to the same social unit and acknowledge the exclusion of others. According to Tajfel (1978), a social identity refers to:

> "That part of an individual's self-concept which derives from her/his membership of a social group (or groups) together with the value and emotional significance attached to that membership."

The social identity approach thus asserts that the process of group identification provides group members with a social identity. The incorporation of the individual within the group thereby facilitates their self-concept in the form of an in-group prototype, i.e. a cognitive representation of the defining characteristics of their own group (Dietler & Hayden 2001). Hogg et al. (1995) point out that these representations or social identities are conceived as being descriptive, consisting of characteristics that are common to all members of a specific group, as well as prescriptive, indicating how the members of a group should think and behave. They also evaluate the relative position of different groups (Hogg et al. 1995, Dietler & Hayden 2001).

The 'family-origin metaphor' is used by Roosens (1994, 1998) to explain the defining characteristics of an ethnic group. He stated that the reasons for all the typical, expected and taboo elements of an ethnic group can be found in the group's history (Roosens 1994, Counihan 1999). Referring to a shared history allows people to obtain a representation of who they are, how they should behave, and how they are different from other ethnic groups. This communal history may not be universal in ethnic group formation, but often plays a crucial part in group formation, and cohesion. The importance of a shared history is illustrated by the occurrence of constructed histories, which takes place even after the group is formed (Counihan 1999).

To summarize, members of different groups will perceive more similarity between themselves and their respective in-group members, than with other people in their surroundings. At the same time the differences between these groups will also be exaggerated. Group members will also perceive more congruence between their own and their group's values and norms, and inter-group competition will increase (Germov & Williams 1999). Group members will favour their own group's members more, resulting in a larger difference between in-group and out-group evaluations. Thus, perceptions will become more favourable for one's own group. Once this sequence has started, these perceptions will tend to reinforce each other by providing an explanation and a justification for one another (Germov & Williams 1999).

Social identity theory points out that these in-group favouring and inter-group comparisons will often be constrained by the existing societal situation. And as such, the dominant groups in society will be able to differentiate themselves positively from the other groups, while minority groups will often experience a negative comparison (Germov & Williams 1999, Counihan 1999). In its so-called macro-social element, social identity theory has specified how these groups will either attempt to maintain their favourable position or how they will react against their unfavourable position (Counihan 1999, Goodman & DuPuis 2002).

The quest for a positive social identity is pursued in different ways in groups who differ in social status. A minority group will have to cope with a low social status, which may, threaten the social identity of its members. By contrast, a dominant group will have a high social status, and its members will try to maintain and defend their position of advantage. This understanding is relevant to the concepts of ethnicity and religious affiliation, though only ethnicity will be considered here, since it relates to a discussion of foodways theory (Brown & Mussell 2000).

4.3 Ethnic Groups

An ethnic group is a type of social organization in which the participants make use of certain traits from their history, which may or may not be verifiable; a definition similar to a social group. Roosens (1989) distinguishes two features of an ethnic group and the consequences of ethnic identity; the establishment of a social border and a psychological identity (Roosens 1989). Barth (1969) described a social border as a result of cultural emblem and value creation. An ethnic identity, in the psychological sense, provides security and a feeling of belonging. This is the basis of the individual's cognitive awareness of their membership (De Vos, 1975; Epstein, 1978, Brown & Mussell 2000).

In his more recent publication, Roosens (1994, 1998) stresses that the creation of a social border is not the sole source of an ethnic identity; instead a person's origin is the prime source of ethnic identity. The ethnic border creates the distinction between people, while the origin creates similarities for people within a group. In this respect Roosens (1994, 1998) again uses the 'family-origin metaphor', relating an ethnic group to the rooted family system. This sense of continuity with the past logically precedes the ethnic border as a foundation of the ethnic identity and ethnicity is more related to origin than ethnic borders. This genealogical dimension differentiates an ethnic group from other social groups such as linguistic or religious (Brown & Mussell 2000, Dietler & Hayden 2001).

4.4 Foodways Theory

According to Leeds-Hurwitz (1990), food is an indicator of social identity and ethnicity as well as age and gender. With this characterization, the presence or absence of particular foods makes a deliberate statement about a person's identity, e.g. intentionally eating only plant products to protest cruelty to animals. Food conveys intentional and subliminal information about many things, like ethnicity, social class, and relationships (Counihan 1999, Brown & Mussell 2000, Dietler & Hayden 2001).

Food also indicates ethnicity. Unique food choice is a result of ethnicity, family, and social group. This presents a static stereotypic concept of ethnic identity that does not exist. Ethnicities, like other group-defined entities, are in a constant state of flux; influenced by members as well as non-members (Counihan 1999, Brown & Mussell 2000).

As archaeologists and anthropologists are accustomed to working with static pictures of a dynamic system, their approach to ethnic food identities tends to be complementary to social identity theory. Social-psychological theories offer a conceptual framework that allows organization of certain anthropological findings. On the other hand, the anthropological insights constitute a counterweight for the occasionally abstract and strict social-psychological theorizes (Dietler & Hayden 2001, Dalby 2002). The integration of both approaches has lead to insights into the role of ethnic identity dynamics in inter-group relations. This combination has resulted in the modern foodways theory (Dalby 2002). Foodways theory can be applied to archaeological and modern analyses; however, it takes on slightly different forms. Since this theory is applied here to the archaeological collection of raspaditas from Santa Isabel, only the former will be discussed. This relatively static approach to the study of food in society does allow for some change in the culture but it is more like a flipbook moving from static photo to photo, than a motion picture.

Transmission of food culture is accomplished by intergenerational food habits and also by the creation and continuance of ethnic or cultural boundaries. There are other restrictions on diet. Environmental determinates include climate, soil, predators, known cultivars, and necessary technological adaptations (Hogg et al. 1995). Social and cultural factors effecting food habits include temporal investment in collection and preparation, religious restriction, cultural restrictions, cultural organization, exposure to other foods, and level of feasting (Figure 4.1) (Dietler & Hayden 2001).

The channel theory proposed by Kurt Lewis (1943) originated the term 'gatekeeper' that can still be seen in modern foodways theory (Epstein 1978). The conjecture behind channel theory is that people eat the food that is served. Food moves through a step-by-step process from the natural environment to the table, with gatekeepers controlling food channels and forces acting upon the gatekeeper and influencing food choice (Epstein 1978). The importance of the gatekeeper has decreased in the modern theory; instead the emphasis is placed on the forces acting on that individual/individuals (Dalby 2002). Other theoretical ideas of the 1940's have had a rebirth in foodways theory including Passim and Bennet's food classifications (1943).

However, their “core, secondary and peripheral foods” have taken on Jerome et al.’s (1980) terms of necessary, liked and tried foods.

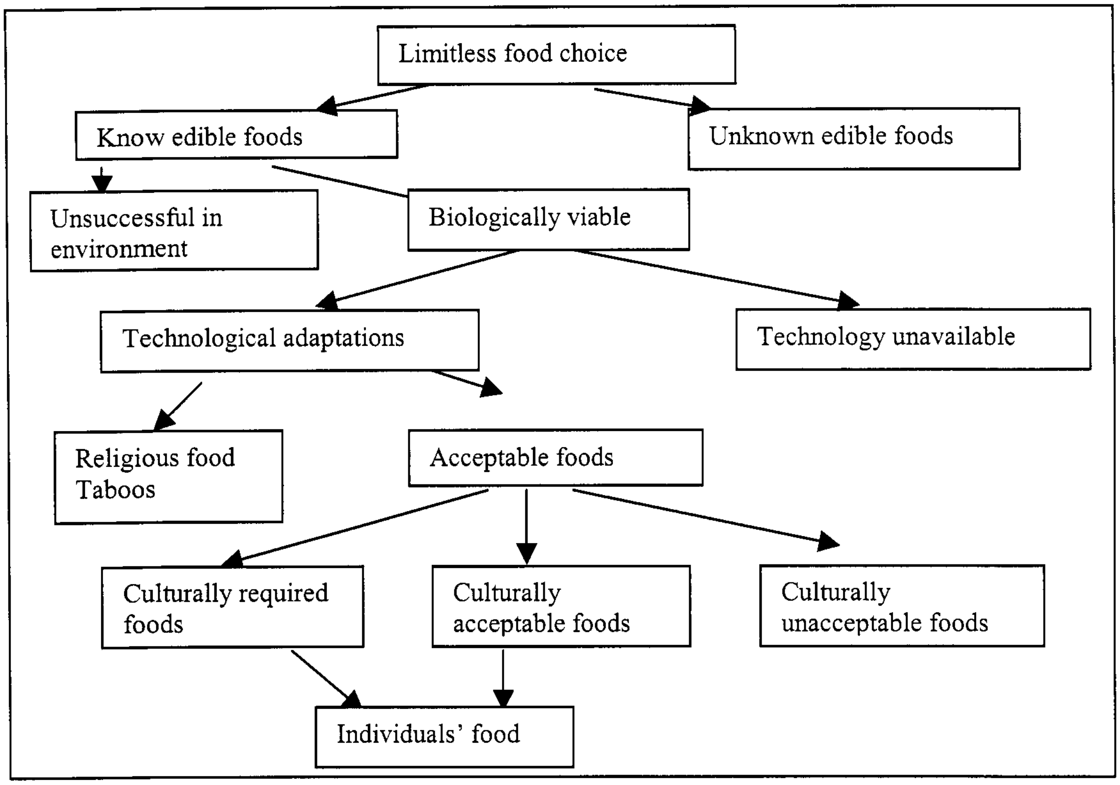


Figure 4.1 Individual food choice. Based on (Germov & Williams 1999)

The common thread in all food theories, including foodways, is the ability to explain the exclusion and inclusion of certain foods in the diet, as well as dietary changes. Once a culturally acceptable way of eating is adopted, the group will not change unless it is acted upon by an internal or external force; the archaeological equivalence of ‘objects in motion…’ Therefore, change such as diet acculturation is now a prominent theme in food studies. The premise behind this is that a group or an individual will adapt to the norms and values of dissimilar cultures (Fieldhouse 1995, Dietler & Hayden 2001). According to Berry (1984), a group can assimilate into the dominant culture by either integrating, retaining parts of its identity, or remaining unchanged and separate from the dominant culture.

The direction the group takes when faced with this external stress is unique and often dictated by internal strain. Anthropologists are actively applying this aspect of foodways theory to refugee nutrition (Romero et al. 1993, Pan et al. 1999, Satia et al. 2002). For archaeologists, this conjecture allows changes in a group's eating habits to be examined with reference to neighbouring or internal groups. Researchers now view food as an ethnic marker (Hogg et al. 1995, Counihan 1999) and explain the changes in observed dietary practices in terms of cultural and environmental forces (Dalby 2002). Therefore, food choices are a result of environment, intra-group stresses and inter-group forces and thus can be used to examine the action of ethnic groups.

4.41 Santa Isabel

Applying foodways theory to Santa Isabel creates a dynamic picture of the people and their culture. The research at Santa Isabel has focused a single occupation phase (890-1280 AD), and as such generates a static picture. Even though no changes in the dietary practices of the inhabitants are presently known, much can be interpreted from the data. Fowler (1989) presents a comprehensive summary of Nicarao dietary practices for Nicaragua, some of which are listed in Table 4.1.

Primary/ Necessary	**Secondary/ Liked**	**Peripheral/ Tried**	**Ritual**	**Seasoning**
Maize (*Zea mays*)	Sweet potatoes (*Ipomoea batatus*)	Cacao (*Theobroma cacao*)	Amaranth (*Amdranthus spp.)*	Chili pepper (*Cupsicmm spp.)*
Beans (*Phaseolus spp.*)	Jicuma (*Pachyrhizus errosus*)	Avocado (*Persea spp.)*	Cacao (*Theobroma cacao*)	Epazot (*Chenopdium nuttalliae*)
Squash (*Cucurbita pepo*)	Pumpkin (*Cucurbita moschata*)	Peanuts (*Arachis hypogaea*)	Tobacco (*Nicotiana tacum*)	Amaranth (*Amdranthus spp.)*
Sweet manioc (*Manihot esculenta*)	Chayote (*Shechium edule*)	Brocket deer (*Mazama Americana*)	Tobacco (*Nicotiana rustica*)	Chipilin (*Crotalia longirostrata*)
Cotton-tail rabbit (*Syvilagus floridanus*)	Tomato (*Lycoperiscon spp.)*	Tree squirrel (*Sciurus spp.)*	Coca (*Erythroxylon coca*)	
Tapirs (*Tapirus bairdii*)	Howler monkey (*Alouatta villosa*)	Anteater (*Myrmecophaga tridactyla*)	White-tail deer (*Odocoileus virginianus*)	
Peccaries (*Tayassu tajacu)*	Spider monkey (*Ateles geofroyi*)	Armadillo (*Dasypus novemcinctus*)	Brocket deer (*Mazama Americana*)	
Ocellated quails (*Cyrtonyx ocellatus*)	Muscovy duck (*cairina moschata*)	Thorny oyster (*Spondylus princes*)	Jaguar (*Felis onca*)	
Wood quails (*Dendrortyx leucophrys*)	Tarpon (*Tarpon atlanticus*)	Olives (*Oliva polpasta*)	Cougar (*Felis concolor*)	
Fresh water shark (*Charcharhinus leucus*)	Mackerel (*Pristis antiquorum*)	American crocodile (*crocodylus acutus*)	Quetzals (Pharomacus mocinno)	
	Freshwater turtle (*Emydidea spp*.)	Brown Caiman (*Caiman crocodiles fuscus*)	King vulture (*Sarcoramphus papa*)	
	Common iguana (*Iguana iguana*)			
	Ocellated quails (*Cyrtonyx ocellatus*)			

Table 4.1 Pre-Columbian Nicarao foods. Note these are only a few of the foods mentioned, they were selected for their importance (Fowler 1989)

Even though foodways theory cannot be used to compare and analyse dietary changes, it can explain certain food choices. The most important foods for Pacific Nicaragua were maize, beans, squash, sweet manioc and fish, birds and mammals, for protein. These foods are similar to the diet throughout Mesoamerica. Santa Isabel's location close to Lake Nicaragua has also allowed a large use of aquatic resources as the four-month dry season required irrigation for the ritually utilized cacao (Figure 4.2). Cacao is an example of an environmentally unsound crop being cultivated due to cultural requirements. In order to grow cacao in Nicaragua, shade trees must be grown along the cacao trees and the fields irrigated during the dry-season (Fowler 1989). To use the vocabulary of foodways theory, cultural stress dictated technological adaptations and behaviour modifications.

Modern foodways theory can be used to clarify a continuing conundrum in Nicaraguan archaeology. There is the lack of early comals, flat shallow bottomed 'tray-like' vessels used to cook tortillas (Lange 1984, Fowler 1989, Johannessen & Hastorf 1994). The classic form of the comal and the tortilla is known to have arrived in Central America during historic times. Fowler (1989) proposed, however, that the thicker, often stuffed, varieties of tortillas still consumed in Veracruz and El Salvador are older forms of the tortilla. To frame this debate in foodways theory, the edibility of a thick or thin tortilla is not as important an issue as the reason for the adoption by Central American populations of Nicarao of Northern Nicarao tortillas in the early historic period. The equation of dietary change is that intra-group stresses plus inter-group forces equal dietary changes (Germov & Williams 1999). So if there were no changes in stress then there should be no change in the diet. External forces resulting from the recent influx of

Spanish culture on the Nicarao of Central America at the beginning of the historic period resulted in a dietary change. To use the social identity theory, a reason for this could be a matter of both ethnic boundaries and shared origins.

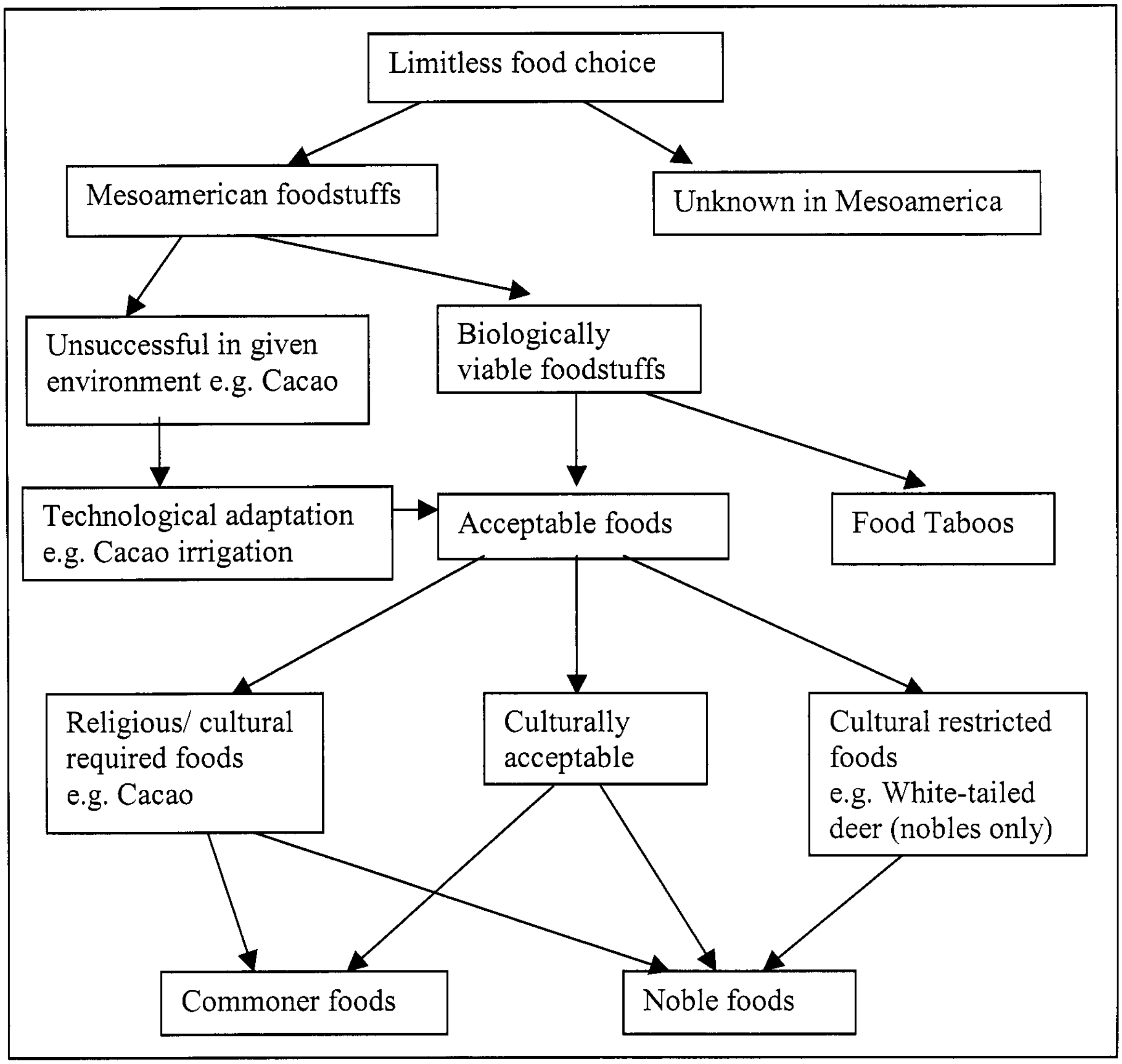


Figure 4.2 An example Nicarao choice of food. Based on (Germov & Williams 1999 & Fowler 1989)

With the influence of Spanish culture, the Nicarao in Central America attempted cultural separation, meaning that they erected a social boundary between themselves and the dominant group. It may have been this same external stress that caused a solidification among Nahuatl groups, evoking strength from their communal history. The adoption of the flat comal and thin tortilla, as a symbol of Nahua culture, easily differentiated it from the Spanish.

The situation of the raspaditas is more difficult to ascertain as the only known location and time period containing the raspaditas is Santa Isabel from 800-1300 AD. Therefore, the question is not temporal change but the meaning behind these food related artefacts. In order to proceed, some assumptions are required. Firstly, it is assumed that the intensive analysis of the lithic record in Northern Mesoamerica would have identified the raspaditas if they were present; secondly, the fact that they have not been identified in other Nicaraguan sites is probably due to poor sampling techniques and the low level of lithic analysis in the country. The final assumption is that the group inhabiting Santa Isabel were the Pipil-Nicarao, a migrant group of Nahuatl speakers from northern Mesoamerica.

The next step is rather speculative as it goes beyond the evidence into the realm of postulation. If the raspaditas are used in the preparation of food, then the exclusion of them from the Northern Nicarao groups who are consuming similar foods means that a special Nicaraguan dish required raspaditas for preparation. Using the thick versus thin tortillas as a comparison, then the dish created using the raspaditas was used as a distinction between different groups of Nicarao. In a sense, the Southern Nicarao were creating an ethnic boundary between themselves and the Northern Nicarao groups.

The reason behind this boundary creation is unknown, but using foodways theory, three possibilities can be discussed, assimilation, integration, or separation (Germov &

Williams 1999). If the Nicarao were assimilating into another native group then a total loss or near total loss of cultural traits would be expected (Hogg et al. 1995, Germov & Williams 1999). This is not evident at Santa Isabel (Healy 1980, Lange et al. 1992, McCafferty et al. 2003). Secondly, the Nicarao could be integrating with another group, resulting in a mix of two or more groups. This possibility cannot be eliminated as researchers still differ on the amount of intact Nicarao culture observed at the time of European contact (Adams 1956, Healy 1980, Lange 1984, Lange et al. 1992, Fowler 1989). It seems unlikely that the introduction of dishes created with raspaditas were attempts to separate themselves from another group, as this distancing is conservative and any change is unacceptable (Germov & Williams 1999).

It is possible that the raspaditas were a technological manifestation of cultural blending resulting from the external stress of another society on the Nicarao migrant group. This would explain their appearance on a Nicaraguan Nicarao site and not Northern Nicarao sites. More data is required including the temporal and spatial extent of the raspaditas throughout the Pre-Columbian landscape to progress further. This is a good candidate for a case study in future foodways theory refinement.

Chapter 5: Methodology

5.1 Field Methods

The University of Calgary's 2000, 2003, and 2004 excavations at Santa Isabel spanned roughly six hectares of the centre of the site. The survey work used both surface collection and shovel-testing methods and included the Residential Mounds 1, 2, 3, 5, 6 and 7 (mound numbers designated by Healy 1980) (Fig. 5.1). Within this survey area, four locations were chosen for the more in-depth unit excavations. These were the areas of Mounds 1, 3, 5, and 6. Artefacts were collected during shovel testing and unit excavation of the site. Therefore, only these field methods will be discussed in detail.

5.11 Shovel Tests

The shovel tests used a standard ten-metre systematic sampling pattern. In this probabilistic strategy, sample units are evenly distributed throughout the sample area at a distance of ten metres from one another. In the area of Mound 6, the grid was decreased to five metres to increase subsurface sampling. The vegetation, climate and crop divisions at Santa Isabel caused the grid to be laid at different angles to the cardinal points in individual areas. The same datum point was used to join the various grids and a composite map of the site created (Figure 5.1).

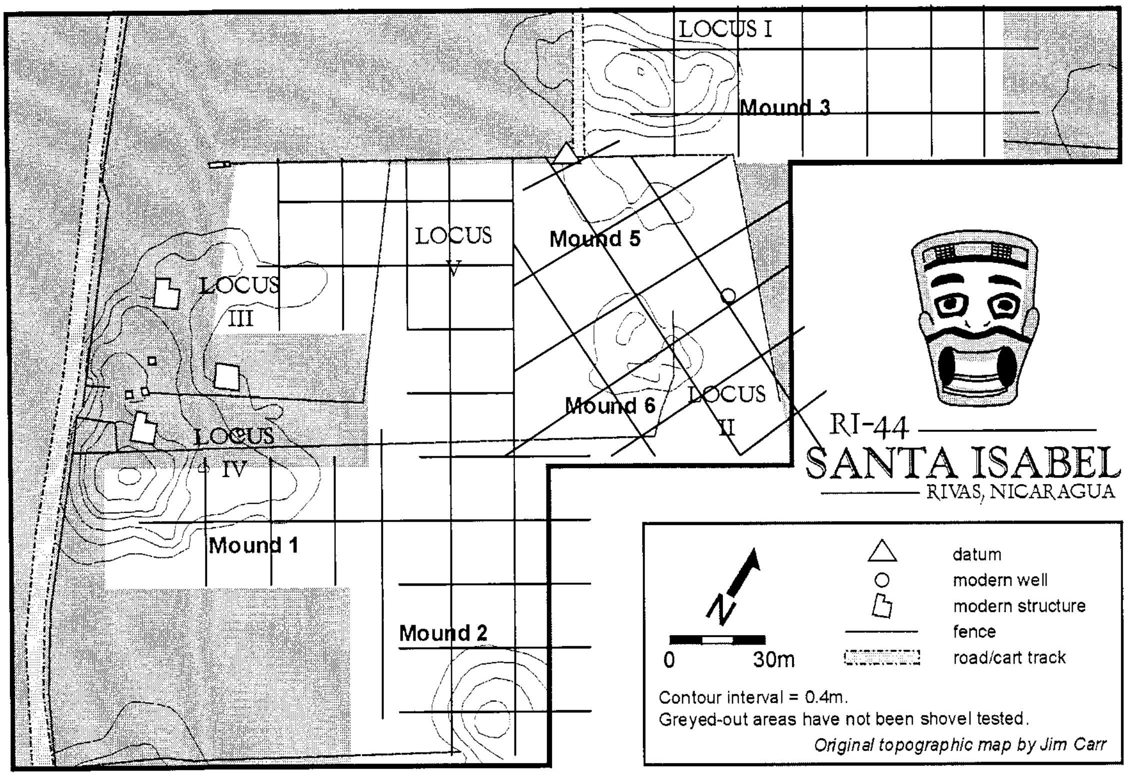


Figure 5.1: Map of Santa Isabel, with shovel test grids overlaid. Note: The different grid used in 2003 in the areas of Mounds 5 and 6. (Adapted from McCafferty & Steinbrenner 2005)

The shovel tests were approximately fifty centimetres in diameter and one metre deep (Figure 5.2). In an effort to control collection, an arbitrary depth division was made with the upper thirty centimetres being collected separately to allow for possible plough disturbance. The lower seventy centimetres were collected without soil colour division. The high soil saturation during the rainy season obscured the natural stratigraphy, as the soils were slow to dry, altering the colours. The first shovel test was excavated, left open to dry and the thickness of the soil layers recorded with dry colours related to Munsell chart. This shovel test contained three levels, which agreed with layers found in larger unit excavations. The three layers were used as a template for all other shovel tests, since subsequent colours were not recorded. Only in situations of dramatic variation from the expected stratigraphy were soil colours recorded. The depth of one metre was selected for shovel tests since excavation with a standard shovel became difficult below this depth. Sterile soil was only reached in a few tests, and was noted.

Figure 5.2 Santa Isabel Locus 5, shovel test in progress. Note: the approximately 50 cm diameter.

The dirt was passed though a standard ¼ inch screen. Artefacts were collected based on their prevalence at Santa Isabel and the goals of the archaeologists. All lithic and faunal artefacts were collected regardless of size. Ceramics were only collected if they were larger than 1½ inches or if they contained decoration or modification. All other artefacts were collected. The two arbitrary levels (upper 30 cm and lower 70 cm) were collected and assigned separate bag numbers and all artefacts were recorded under this number. Artefacts of different classes were placed in separate bags under the same number to decrease bag damage.

5.12 Unit Excavations

A standard excavation methodology was established in the first season (2000) and continued in the same manner in later field seasons. The term ‘unit’ was applied to each $1m^2$ excavation, which was given its own designation (Figure 5.3). The name of the unit corresponded to the location in the grid of the field established during shovel testing. When a unit was expanded, the addition would receive a new unit number. Thus, information about the size and location of the unit was contained in its name, i.e. S40 W65. The units were excavated in ten centimetre arbitrary levels. The natural boundaries, colours and soil textures were recorded in each arbitrary level. Soil samples were collected from the southwest corner of levels below 30 cm as well as from features in 2003 and 2004. In 2000, soil samples were only collected from features. This change in field methodology reflects the addition of flotation to laboratory procedures in 2003 and 2004.

The criteria used for artefact collection during unit excavation were the same as for the shovel tests. The only difference was that artefact provenance was recorded for large or exceptional pieces (Figure 5.4). Unit excavations took place simultaneously throughout the site in many different localities. Operation numbers were assigned to larger areas of excavation. Bag numbers were assigned in series to a unit excavation from a master sheet. This meant that bags in succession came from the same unit but the numbers held no geographical significance.

Figure 5.3 2003 Locus 2 Operation 5 Unit S70 E65, Level 9 (80-90 cm).

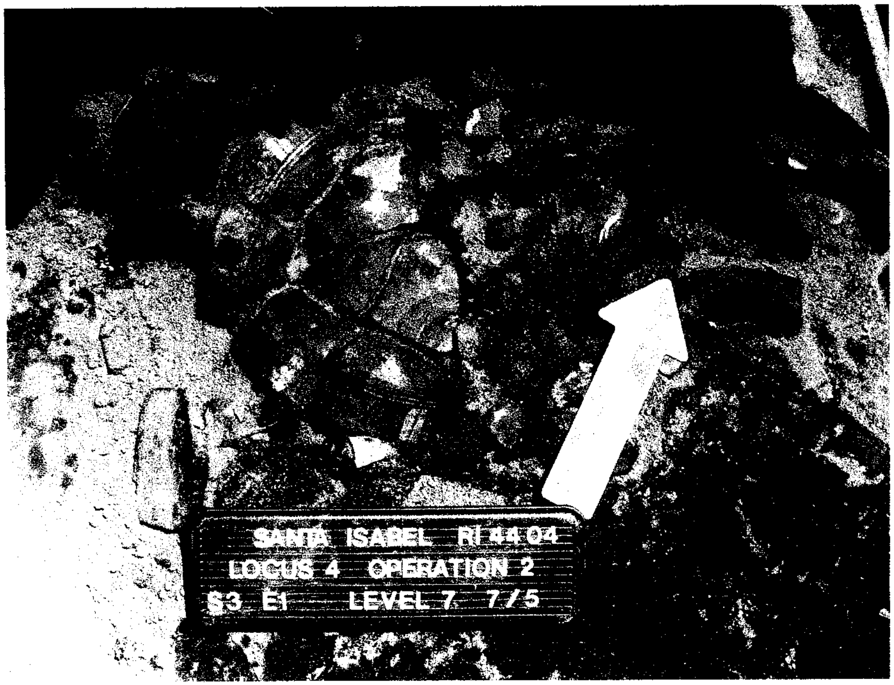


Figure 5.4 Partial polychrome vessel: showing the record of provenance.

In 2004, an even larger number of units were opened. Therefore, each field was assigned a locus number, under which there were several operations, each with multiple units. This changed the recording system for bag numbers. Bag numbers were assigned within each locus completely independently of the remainder of the site. Sequential bag numbers still imply the same unit, but now several units had the same bag numbers. Therefore, the locus number always precedes the bag number for artefacts collected in 2004.

5.2 Laboratory Procedures

After collection, the contents of all artefact bags were counted and initial counts recorded. Depending on the artefact type, they would either be washed or bagged for storage, as was the case with undecorated, unmodified body sherds. After drying, the different artefact classes were bagged separately and recounted. Some artefact types were assigned an individual object number. Lithics tools were issued object numbers and flakes were counted under their bag number.

Object numbers for shovel tests and unit excavations in 2000 and 2003 started with the site designation (RI.44), the year of collection (.03), and bag number (.246); the last two digits are the object number (RI.44.03.246.**01**). For excavations in 2004, the locus number was inserted before the bag number (RI.44.04.**4**.246.L02). Another change in 2004 was the switch to artefact class separation in object numbers. In 2000 and 2003 object numbers were assigned from a master list regardless of type of artefact. In 2004, lithic object numbers were preceded by L, ceramics C, faunal remains F (RI.44.04.4.246.**L**02).

5.3 Raspadita Measurement/ Attributes

The length, width, and thickness of all raspaditas collected in 2004 were measured with callipers. The length was defined as the distance from the proximal end of the tool to the distal tip (Fig. 5.5A), although for the broken tool this may not be the largest dimension. The width was considered to be the widest part of the end; this was usually perpendicular to length. In the case of asymmetric raspaditas, the width was measured along the use edge (Fig. 5.5B). The thickness was measured as the maximum difference between the dorsal and ventral surfaces, regardless of location. The region from midsection to end was usually the thickest.

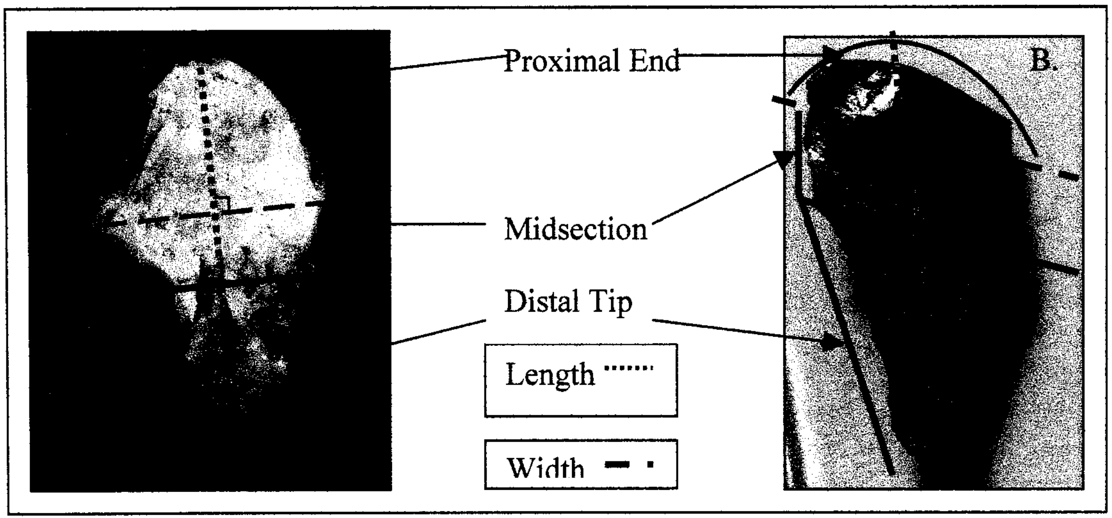


Figure 5.5: Raspadita divisions and measurements. (A.) Symmetric raspadita. Note: Midsection starts and ends with a change in the slope of the lateral angle and the length measurement bisects the tool perpendicular to width, along a mirror plane of symmetry. (B.) Asymmetric raspadita. Note length and width are not perpendicular and the tool has no mirror plane.

The edge angles were measured with a contact goniometer by holding the ventral surface against the protractor plate with the arm on the dorsal edge surface (Figure 5.6). Measurements were taken provided at least a portion of the end was unbroken. Angles were measured in several places on each end and the average recorded.

The location of usewear, seen through a hand lens, and the lithic material type were recorded for all raspaditas collected during the three field seasons. Variations in form were also recorded in 2004 after the typical characteristics of the raspaditas had been recognized. These variations included breakage pattern, surface polishing, form and possible heat-treatment. Breakage patterns were recorded by location as end, tip or mid section, and as parallel, perpendicular, or transverse to the length of the tool.

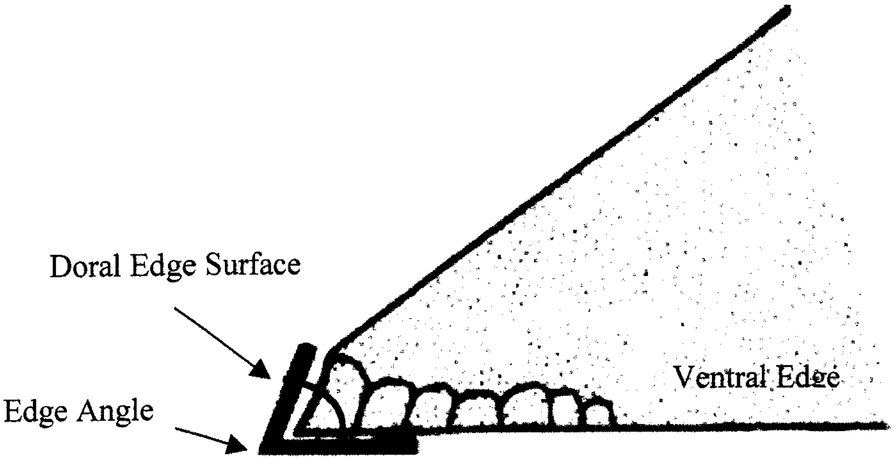


Figure 5.6 Edge angle measurements. (Adapted from Burgess & Kyamme 1978)

Several raspaditas were highly polished. This polish, which was readily discernable in hand sample, causes reflective surfaces and reduces topography. The polish was recorded as present or absent. The location of the polish was not recorded, because at the macroscopic level, it always covered the entire tool.

The colours of the tool were recorded in the order of their predominance. The first colour was that of the majority of the matrix, which was sometimes followed by another colour indicating that the matrix contained two colours. The inclusions were recorded after a colon. An example (Wht,Pi:B,G,Pi,P) tool would have a white and pink matrix, black, grey, pink and purple inclusions, in a deceasing amounts. The assignment of colours was based on a predetermined division between shades of paint samples. Inclusions or matrix colours were assigned the closest paint chip colour. Traces of manufacture that remained on the raspaditas were also recorded and used to determine the type of fabricator used, core type and retouch technology.

5.4 Statistical Methods

A statistical analysis of the length, width, thickness and edge angle of the raspaditas was under taken to determine if the raspaditas constituted a definable lithic tool class. Only the 244 complete unbroken raspaditas were used for the dimensions measurements, however, a total of 1349 raspaditas contained unbroken end sections and were used for the edge angle category. Co-variation and correlation factors were used to determine if there was a dependence of the length, width, thickness and edge angles of the raspaditas.

5.41 Cluster Analysis

Cluster analysis was applied to all unbroken lithic tools (698) collected from Santa Isabel in 2004. The characteristics entered were length, width, thickness, edge angle, material type, facialness (uni or bifacial), retouch and use locale. Seven asymmetric raspaditas, five axes, fifteen bifaces, twenty-one blades, twenty-two borers, four choppers, thirty-one drills, three hafted blades, twenty-four hafted knifes, ten hafted scrapers, fourteen knives, one multitool, sixteen perforators, fifteen points, two hundredforty-four raspaditas, one hundred-eleven scrapers, three spokeshaves, one hundred-fifty utilized flakes and two pieces of utilized shatter were included.

5.42 Excel Database

The geographical coordinates and depth data for all raspaditas collected in 2004 were entered into an Excel spreadsheet. They were then grouped by locus and ordered by bag number from the lowest to the highest. Each unit was first examined individually, because as the units were excavated in arbitrary levels, raspaditas collected in one layer could be from the same deposit as adjacent layers. Also, the majority of the raspaditas were found in the screen and their location in the $1m^2$ 10cm level is unknown (Figure 5.7). There was no reason to assume that the arbitrary levels are similar throughout the large area surveyed, therefore totals counts were used. Using totals does not remove depth as a source of error as some units would have been deeper than others but, since Santa Isabel is a single occupation site, it creates one large coherent unit of time. Therefore, unit totals were entered into the database rather than level totals.

5.43 Geographical Information Systems (GIS)

The site of Santa Isabel was surveyed with several different grids. Each locus was imported from the Excel spreadsheet into ArcView as a separate database. Archaeological patterns were determined in Arcview. The shovel testing data was viewed across the site. The large artefact categories of lithic tools and ceramics were compared to assess their ability to identify known cultural deposits.

The location of lithic tools was compared to raspaditas for Locus 1. For each of the loci excavated in 2004, raspadita data were mapped and compared. The raspadita data were examined to determine the site-wide distribution as well the ability of this artefact class to identify cultural areas.

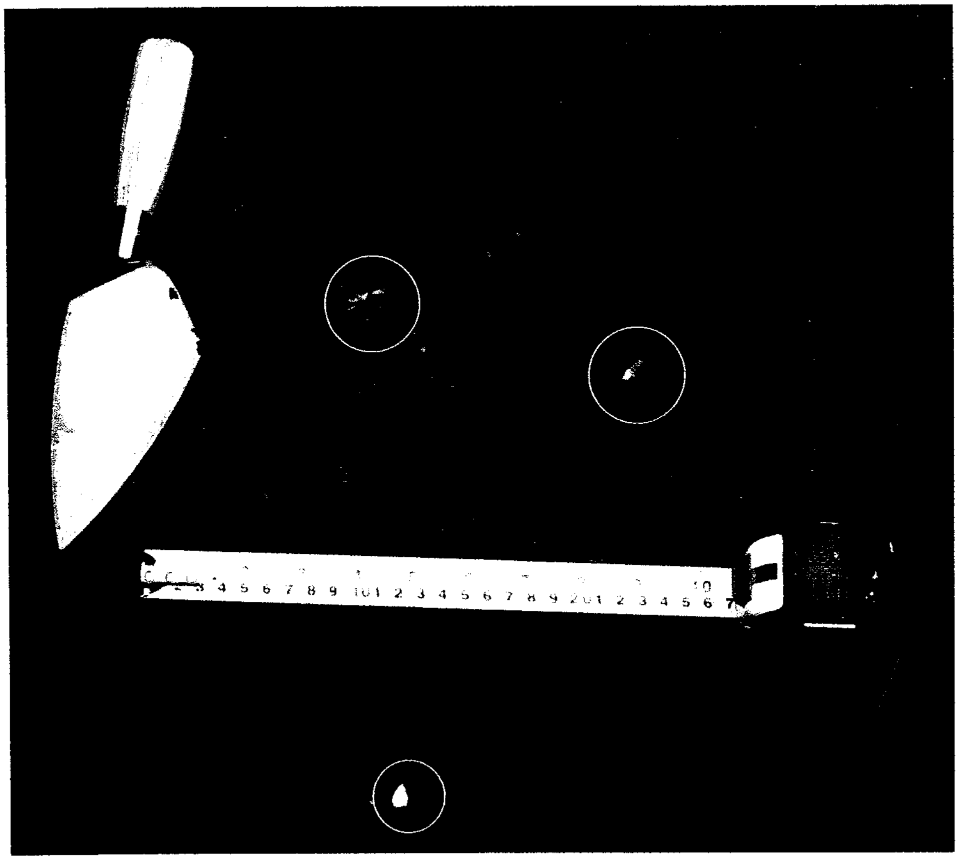


Figure 5.7 Raspaditas found in situ. 2004, Locus 4, Operation 2, Unit S3 E1, Level 6.

5.5 Usewear Analysis

5.51 Macroscopic Usewear Analysis

The location of usewear was determined by the examination of the raspadita's surface with a 10x hand lens for all raspaditas collected at Santa Isabel. The usewear locations of raspaditas collected from 2004 were selected for entry into the database because of the large number of complete tools.

5.52 Microscopic Usewear Analysis

A sample of 125 intact raspaditas (50 from 2003 and 75 from 2004) was selected for microscopic usewear examination. Raspaditas that had some soil coating them were set aside for residue analysis. About 70 other raspaditas were cleaned and examined under a binocular microscope. Of these 26 were selected for scanning electron microscopy (SEM) based on their completeness and the presence of usewear. Four tools, similar in form to the raspaditas were also examined under the SEM. They included a tanged point, a broken end scraper, a drill and a perforator. The shape of these tools was considered to be beyond the typical variation of raspaditas. These were used to verify the boundaries applied to the characteristics of the raspaditas, and their functional qualities were evident in different usewear patterns.

The usewear of each lithic tool was recorded by location on the tool (end, tip, and midsection) and by the part of that section (body, edge, ridge, depression or arris). The type of usewear was described as (1) microchipping, i.e. small flakes removed during use not exceeding 5mm (Kooyman 2000); (2) micropolish, i.e. a general smoothing and removal of topography, caused by abrasion (Andrefsky 1998); and (3) striations i.e. linear scratches caused by abrasion (Kooyman 2000). Microchipping was recorded as step terminating, transverse, perpendicular, isolated or chained; polish, as fully or partially developed or rounded; and striations as perpendicular, parallel or transverse to the edge and isolated or grouped.

The raspaditas selected for scanning electron microscopy (SEM) were washed in ultrasonic baths of soap and water, then double distilled water and finally acetone. The acetone was necessary to remove the clear nail polish and permanent marker on some of the tools, to kill any organics and to dry the samples before mounting and coating. Raspaditas were mounted onto individual aluminium stubs. Carbon paint was used to stick 12 of the samples to the stubs. Carbon tape was used for another 18 samples, as this proved to be more effective in adhering to the undulating surface of the tools. The raspaditas were coated with gold under a vacuum before being placed inside the vacuum-sealed chamber of the SEM. This coating, the disk and the adhesive must all be non-magnetic, to prevent "charging" which causes electron scatter (Knutsson 1985).

An electron beam was scanned across the surface of the sample. When the electrons made contact with the surface, secondary electrons were released. These are picked up by a detector which consists of a scintillator that emits light when it was hit with the electrons and a photo multiplier that picked up the light signal and produces an amplified electrical output (Potts et al. 1995). Collection of these secondary electrons produced 3D topographic images.

5.6 Extraction of Residues

Residue analysis was conducted on three tools. The loose soil was removed, and the surfaces washed with distilled water and dilute HCl. The runoff was collected and centrifuged. The liquid was decanted and the concentrated material mounted on a glass slide and covered. The concentrate was then examined with an optical microscope, utilizing both plane- and crossed-polarized light. The maximum width and length of the particles, as well as morphological data, such as shape were recorded. These characteristics were compared to similar particles in the literature, as there is not a collection of Nicaraguan flora for comparison.

5.7 Chert Sourcing

The location of chert used in the manufacture of the raspaditas and the other Santa Isabel lithic tools was investigated. Samples of chert were collected from outcrops along road cuts and the Pacific Coast of Northern Costa Rica and Southern Nicaragua (Figure 5.8).

Samples of chert were made into thin sections and examined under an optical microscope. There was considerable variation between and within outcrops and only those with macroscopic characteristics similar to the raspaditas were selected for optical analysis. They were then compared to thin sections of four raspaditas and one pink chert drill. The lithics were chosen as they displayed the full range of rock colour and texture.

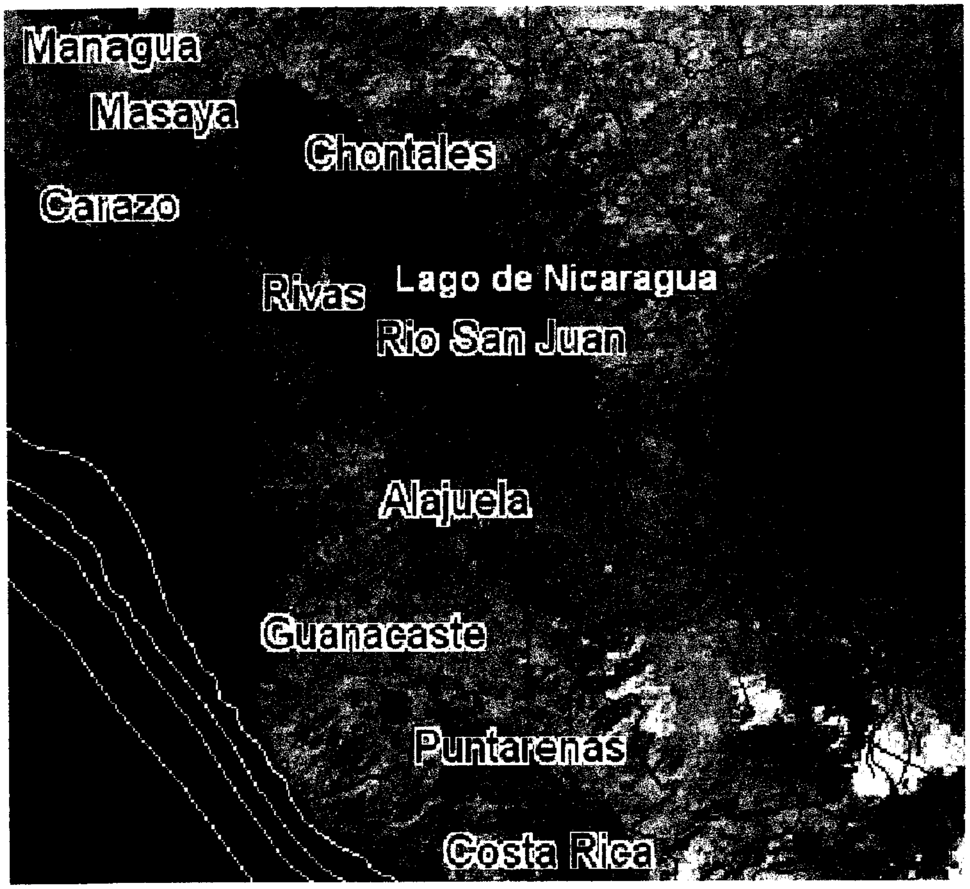


Figure 5.8: Chert collection sites. (Adapted from MapMart 2004)

1	By the town of Puerto Moreno, Costa Rica	5	Punta Majagual, Nicaragua
2	By the town of Chumico, Costa Rica	6	Just outside Bocana El Coyol, Nicaragua
3	By the town of Bahia Brasilito, Costa Rica	7	South of Bocana El Coyol, Nicaragua
4	Punta Ple Del Gigante		

Chapter 6: Results

6.1 Spatial Analysis

Projecto Santa Isabel is a work in progress, with excavation continuing in 2005 and, therefore, different aspects are at various levels of completion, including the spatial data. The locations of all shovel tests have been entered into an Excel spreadsheet and can be mapped (Figure 6.1A), and all the unit excavations have been mapped within most loci. However, the information that is associated with the location data is variable. For 2000 and 2003 there are total counts for ceramics, bone and lithics, but the lithic data is not separated into tool classes so the raspaditas cannot be mapped; whereas the 2004 data does include the lithic tool classes.

6.11 Shovel Testing

The excavations at Santa Isabel lasted up to two months, with intervals of at least nine months. At the start of each new field season the landscape had changed, e.g. the total clearing of a banana field or the regrowth of a previously open area. Therefore, only one or two fields were surveyed at any time. In 2000, a small crew surveyed the area around Mound 3 called Locus 1 and dug several one-by-ones. In 2003, the area of Mounds 5 and 6, Locus 2, as well as a large low lying area, Locus 5, was surveyed; with excavations on and adjacent to Mound 6. In 2004, a larger portion of Locus 5, Locus 4 on Mound 1, the low-lying area between Mound 1 and 2, and Mound 2 were surveyed (Figure 6.1A,B,C).

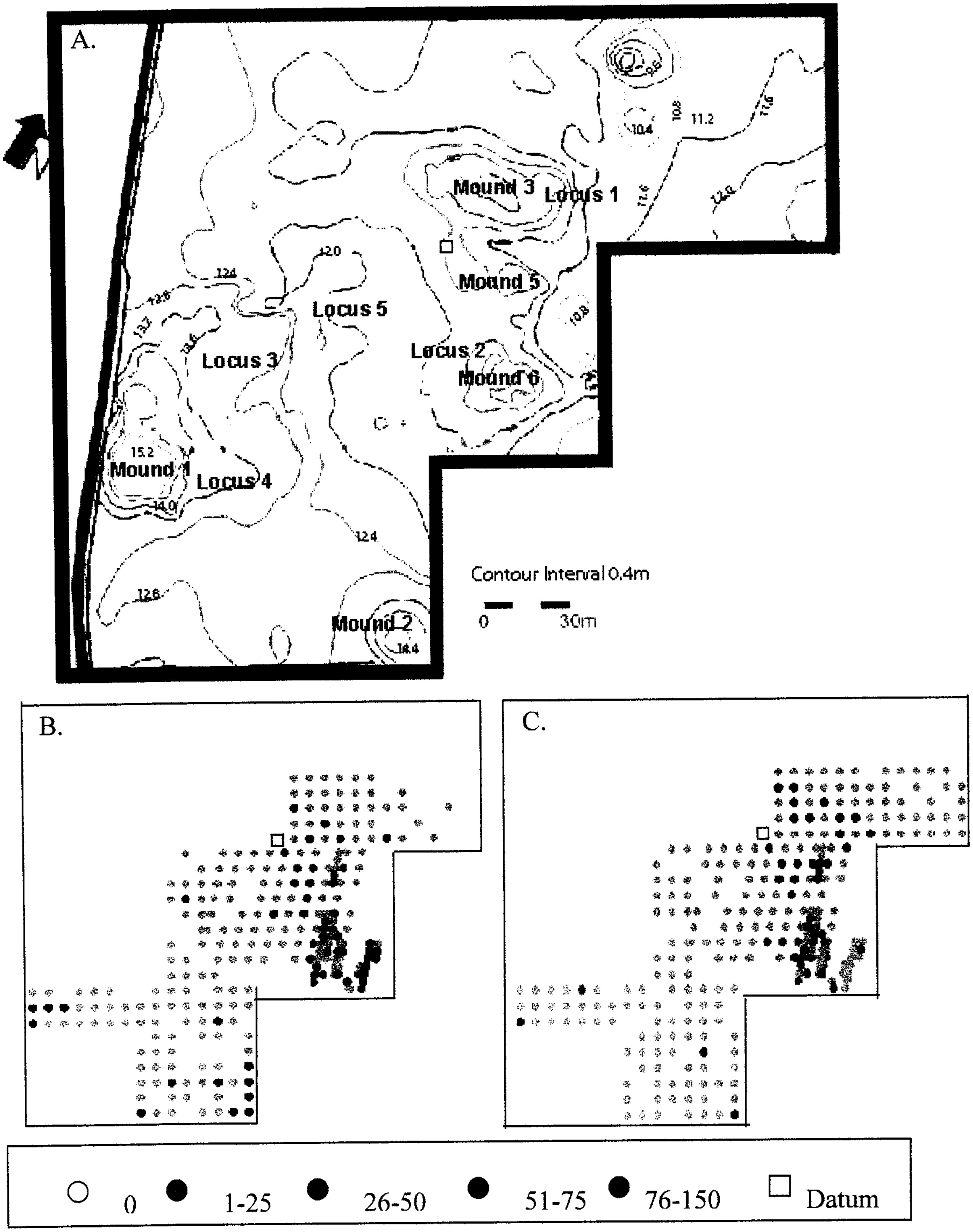


Figure 6.1 Site maps of Santa Isabel. (A.) Contour map showing mounds and general topography. (B.) Number of lithic tools found in each shovel test. (C.) Number of ceramic rim sherds found in each shovel test. Note circles are approximately 10 meters apart, except in the area of Mound 6, where they are 5 meters apart. Artefact density is shown as colour differences not circle density. (Adapted from Jim Carr's unpublished map)

General artefact classes have been recorded and are compared in Figure 6.1. The mounds are clear in both projections as concentrations of artefacts. The lithic tool concentrations give higher values around the cultural mounds than the ceramics and thus increase the visibility of these cultural deposits. Mound 2 in the SW of the site shows this difference. At Mound 2, two shovel tests have 76-150 lithic tools and one has 50-75, whereas there is only one shovel test with 26-50 ceramic rim sherds. Mound 1 is not visible in either projection, due to buildings in the area causing and transects to be placed south and east of the mound.

6.12 Locus 1

Locus 1 includes a large portion of Mound 3 Figure 6.2A). In 2000, several units were placed on and adjacent to the mound and in the low-lying area to the northeast. In 2004 this excavation was expanded on top of the mound. The locations of the non-raspadita lithic tools and raspaditas collected in 2004 were mapped (Figure 6.2 B, C). The patterns of these two artefact classes are similar.

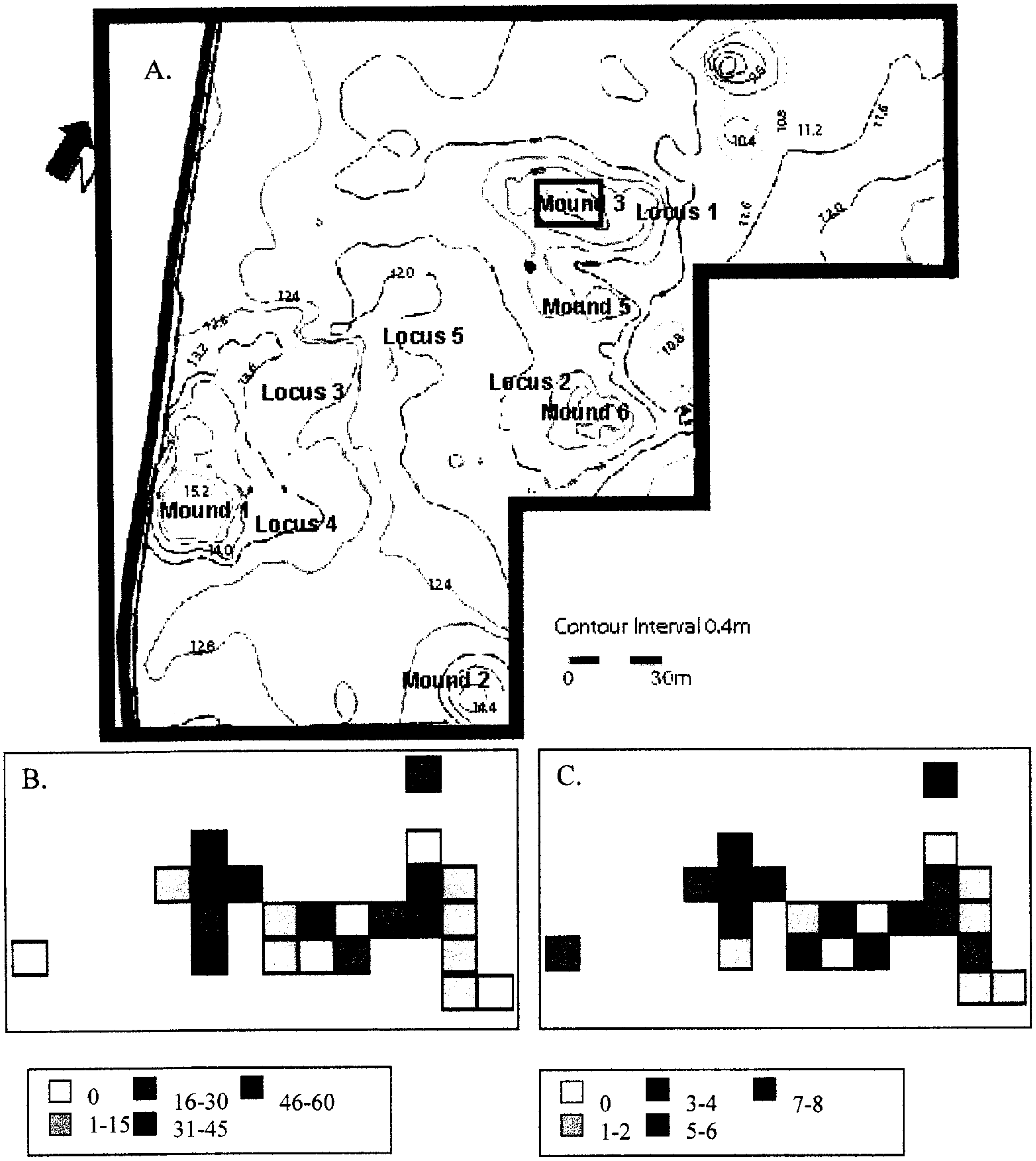


Figure 6.2 Locus 1, Mound 5 Distributions in 1m^2 units. (A.) Santa Isabel topography. (B.) Non-raspadita lithic tools from 2004. (C.) Raspaditas from 2004.

6.13 Raspadita Spatial Analysis

When the location of all the raspaditas collected in 2004 are mapped, a similar pattern of concentration is visible (Figure 6.3). There are two units with large numbers of raspaditas off the mounds in an area between cultural occupation regions. Locus 5 is comprised of a low-lying area, which contains several of the human burials excavated at Santa Isabel. Therefore, the raspaditas found in high concentration at Locus 5 indicate some type of cultural activity but not the same as the house mounds.

The majority of the excavation units contain 1 to 20 raspaditas. There were four units containing over 60 raspaditas. The first of these units is in Locus 4, on the slope of Mound 1. The second unit is in Locus 5 in the low-lying area between Mounds 1, 6 and 3. This unit is associated with human burials. The final three units are all in Locus 2 on Mound 6. The unit in the northwest corner of Locus is associated with a possible kiln or hearth feature. The two units in the southeast of Locus 2 are associated with a number floors and walls. Thus, the raspaditas appear to follow the lithic tool pattern of clustering around cultural deposits, including non-domestic areas.

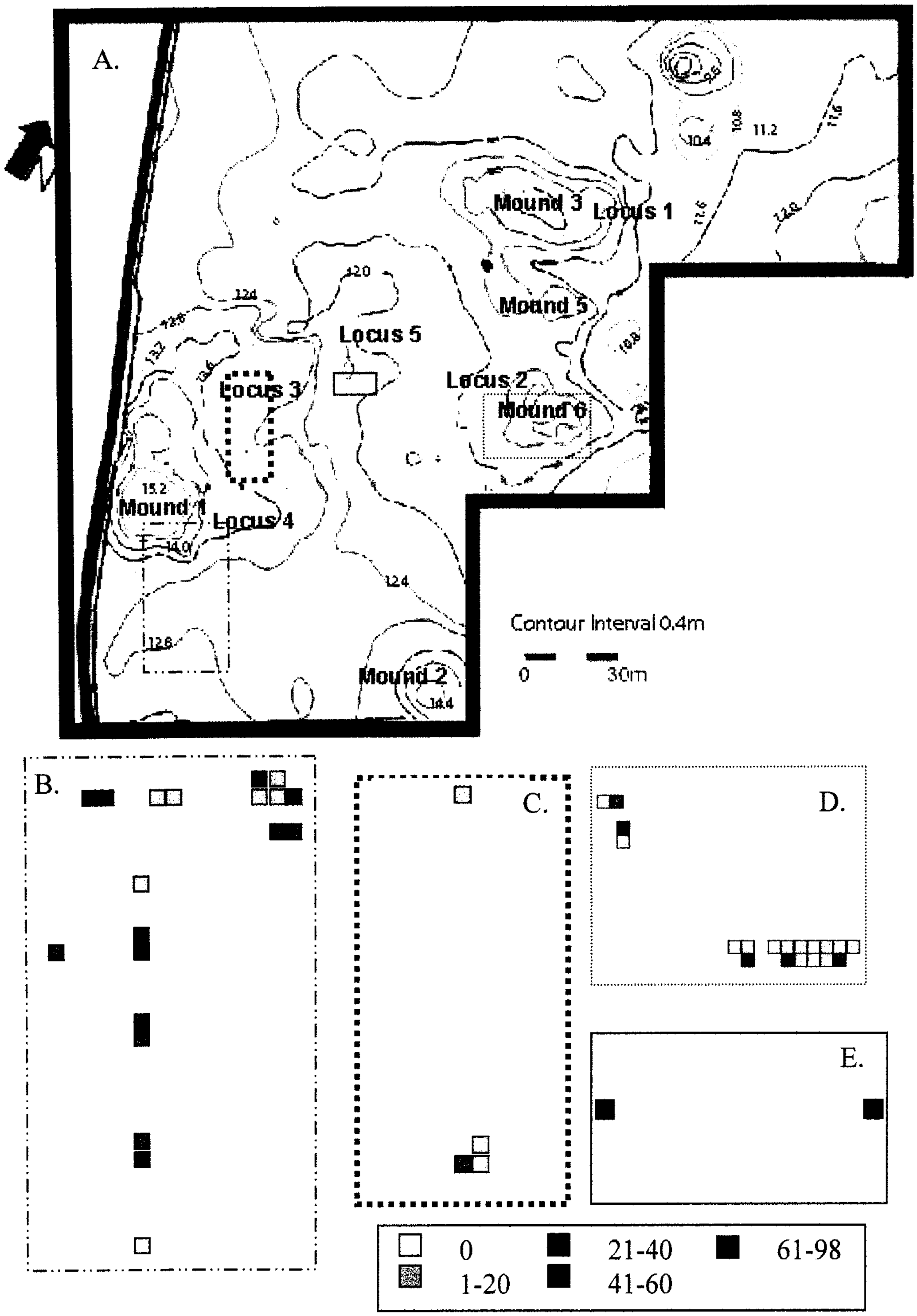


Figure 6.3 Raspadita distributions in 1m^2 units. (A.) Santa Isabel topography; (B.) Locus 4; (C.) Locus 3; (D.) Locus 2; (E.) Locus 5.

6.2 Statistical Analysis

In order to determine if the raspaditas constitute a coherent tool class, the variation within the class was examined. Detailed measurements were taken of the raspaditas collected in 2004, with the dimensions of complete tools being used to establish the size characteristics.

The form of the raspaditas is uniform, always containing a proximal convex surface and a distal tip (Figure 6.4 A, B). There are two variations of raspaditas identified at Santa Isabel, symmetric and asymmetric forms. Symmetric raspadita are identified by a mirror plane of symmetry along the length of the tool, bisecting the end at 90°. Asymmetric types are defined when this bisection takes place at any angle other than 90° and the mirror plane of symmetry does not exist.

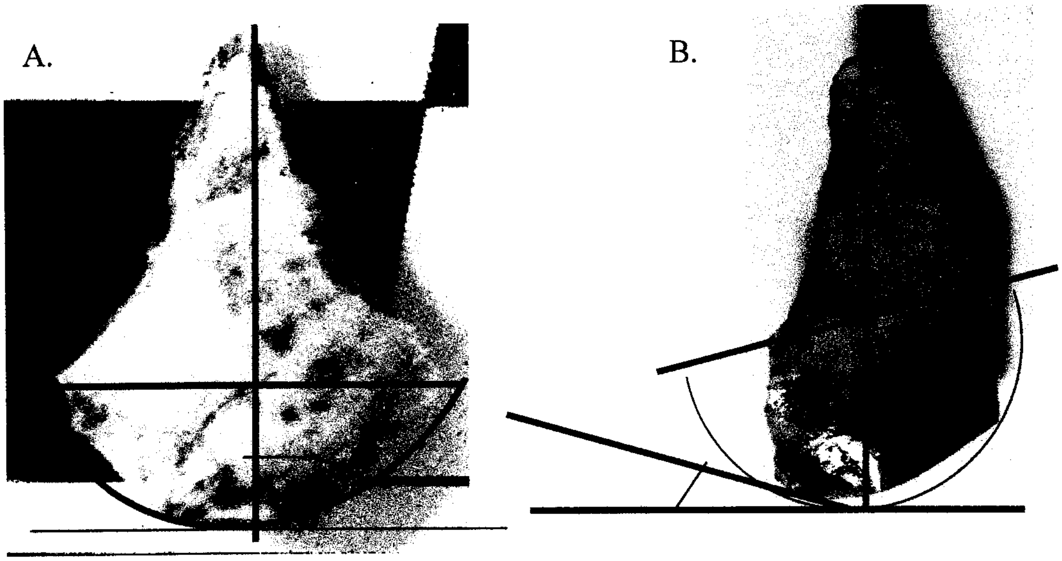


Figure 6.4 Raspadita lines of symmetry. (A.) A symmetric raspadita. The tangent to the curve of the end surface creates a 90° angle. (B.) An asymmetric raspadita. The tangent to the curve of the end surface creates an angle other than 90°.

There were 244 unbroken raspaditas, from the 2004 collection, with an average length of 1.50 cm and a range of 0.75 - 2.6 cm with a standard deviation of 0.37 cm. The average width is 0.89 cm with a range of 0.4 - 1.8 cm, with a standard deviation of 0.24 cm and an average thickness is 0.48 cm 0.2 - 1.0cm, with a standard deviation of 0.15 cm. The length of the tip ranges from 0.98 cm to 0.37 cm with an average of 0.54 cm (Figure 6.5, Table 6.1) and an average diameter of 4.2 cm (0.31 to 0.47 cm).

Measurement	Smallest (cm)	Largest	Average	Standard Deviation
Length	0.75	2.60	1.50	0.37
Width	0.40	1.80	0.89	0.24
Thickness	0.20	1.00	0.48	0.15
Length of tip	0.37	0.98	0.54	0.09

Table 6.1: Measurements of Raspadita dimensions.

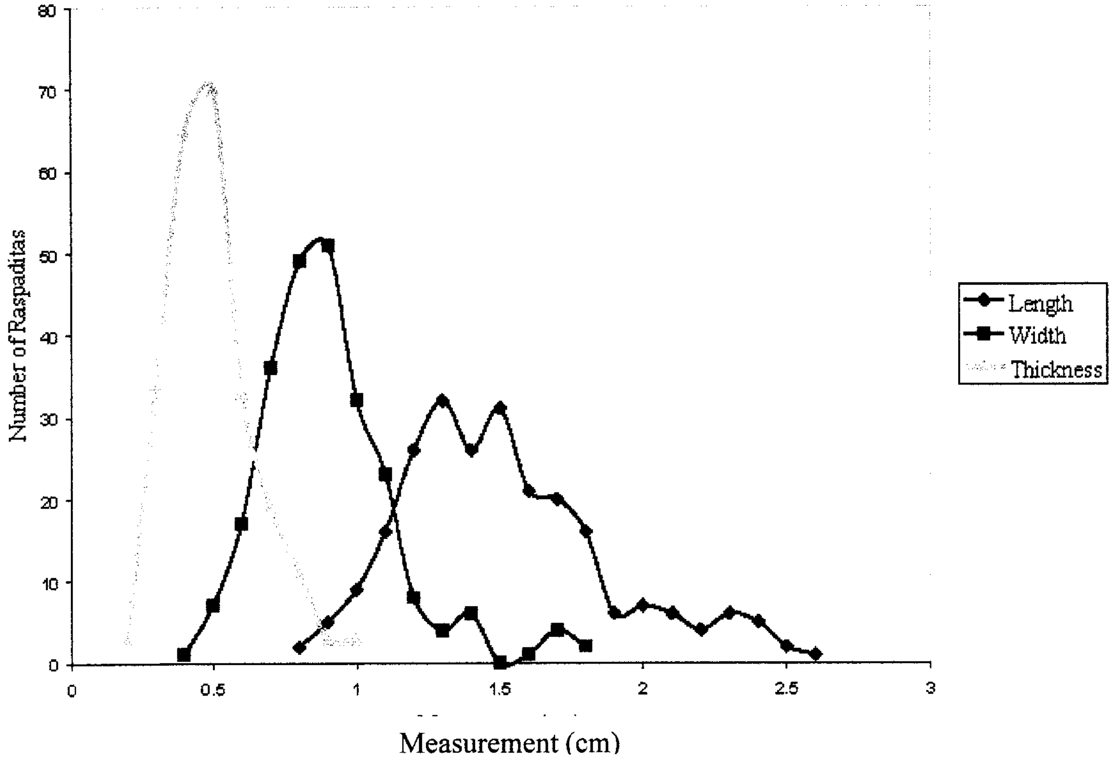


Figure 6.5 Distribution of raspadita dimensions. Note the normal distribution of the thickness and width measurements.

The dimensional co-variance and correlation factors were determined for the raspaditas collected in 2004 (Table 6.2). The relationship between length and width is the most dependant, having the highest co-variation. However, all dimensions co-varied with each other to some extent, meaning that as the raspaditas increase in length, so to did the width and thickness.

	Length	**Width**	**Thickness**
Length	1		
Width	0.039 (0.45)	1	
Thickness	0.024 (0.43)	0.016 (0.44)	1

Table 6.2: Co-variation of raspaditas dimensions. Correlation coefficients are given in parenthesis.

When the raspaditas are compared to the dimensions of the other complete tools collected in 2004 at Santa Isabel (Figure 6.6A, B, Figure 6.7 A, B, Figure 6.8 A, B) they cluster at low values in all three comparisons. There are some tool classes with individuals that plot in the same area size as the raspaditas. However, there is considerably more variation within these other groups. Drills, perforators, and borers are the tool classes closest to the raspaditas, but they do not have edge angles, and thus are easily separated based on this characteristic. Other tools that appear to be similar to the raspaditas based solely on shape are hafted knives. Edge angles can be used to separate them from the raspaditas as the hafted knives have quite acute edge angles, none being greater than 50° whereas the raspaditas have considerably larger edge angles, with a range from 58-123°.

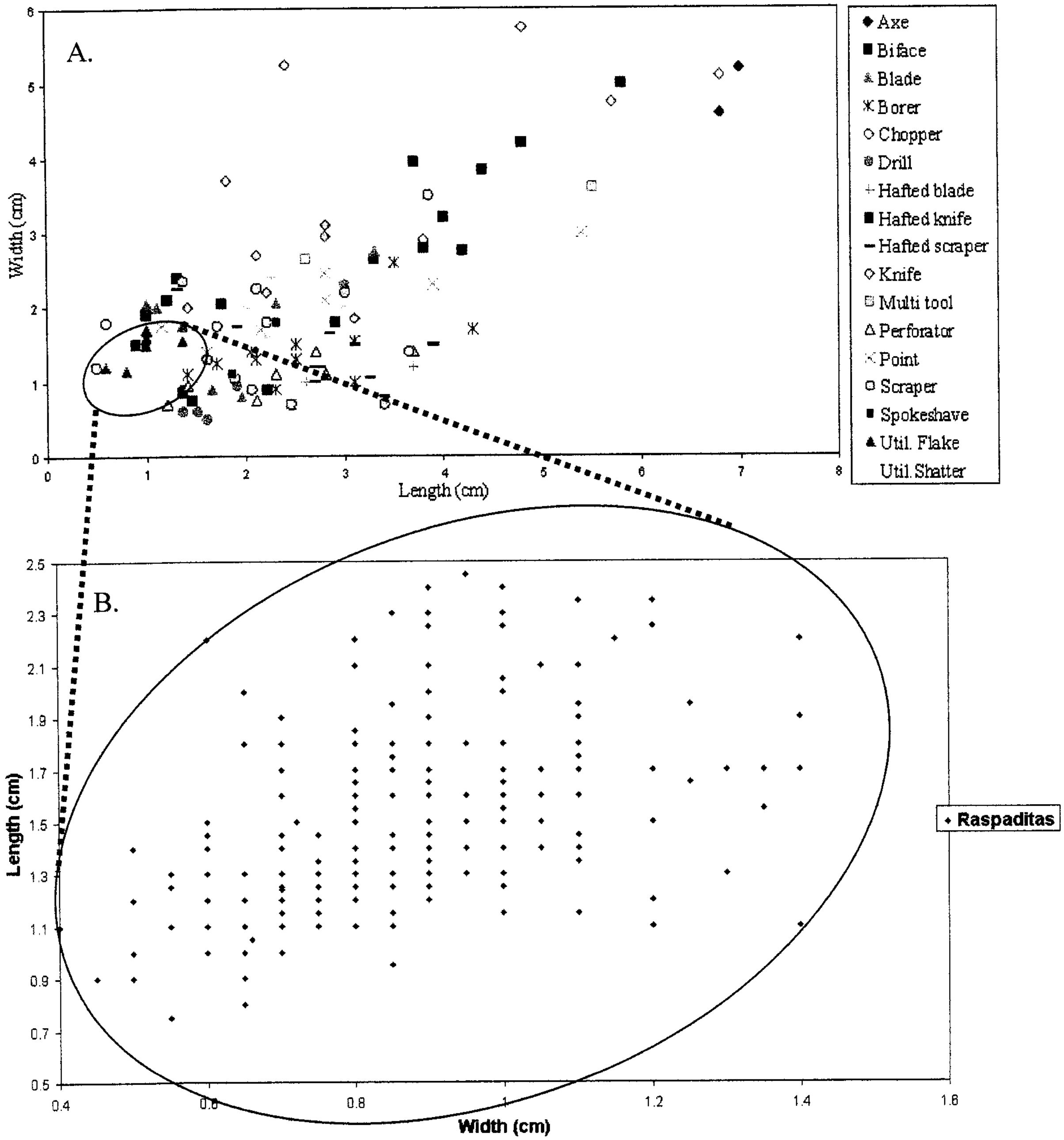


Figure 6.6 Length/ width tool comparisons. (A.) All complete tools from 2004. Note for clarity the raspaditas are not plotted, but are represented by ellipse. (B.) An enlarged plot of raspadita dimensions.

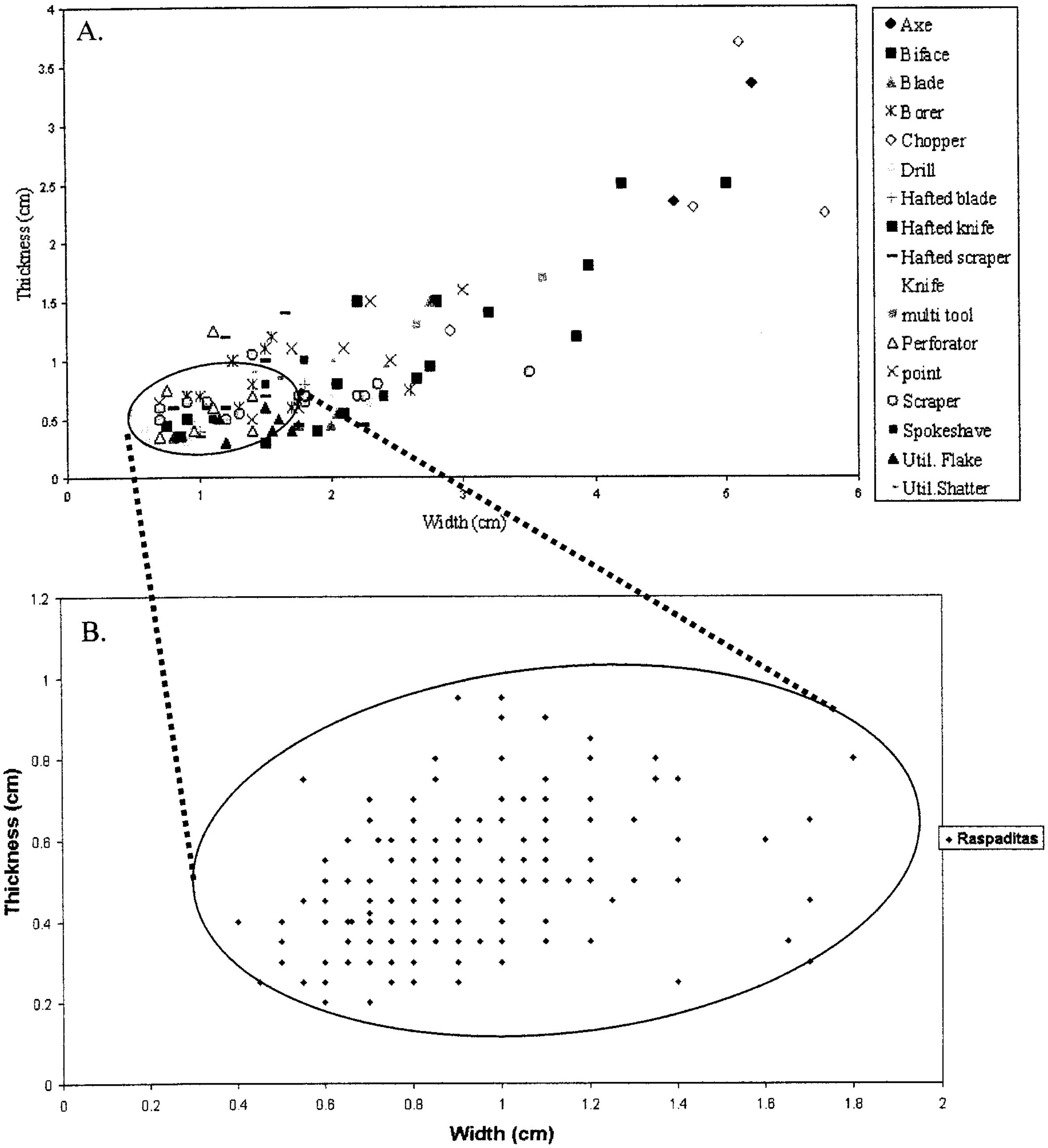


Figure 6.7 Width/ thickness tool comparisons. (A.) All complete tools from 2004. Note the raspaditas are not plotted, but are represented by ellipse. (B.) An enlarged plot of raspadita dimensions.

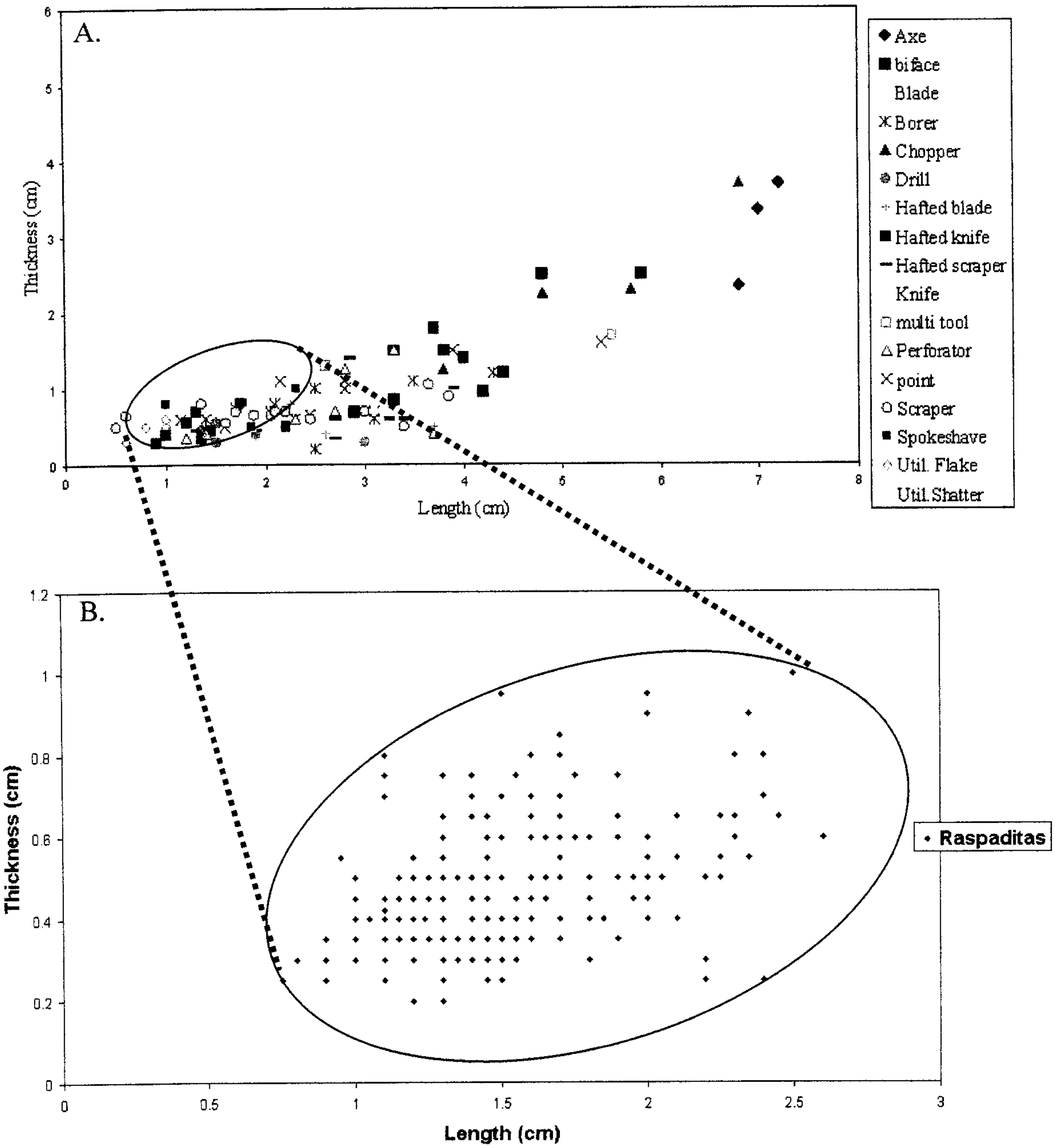


Figure 6.8 Length/ thickness tool comparisons. (A.)All complete tools from 2004. Note the raspaditas are not plotted, but are represented by ellipse. (B.) An enlarged plot of raspadita dimensions.

Edge angles are important for raspadita identification but also provide information about their function. The edge angles of the 1,004 complete and almost complete raspaditas ranged from 58° to 123° and cluster from 71° to 115° with a dip around 96-100° (Figure 6.9). This is in the expected range for scrapers of 60-150° (Andrefsky 1998).

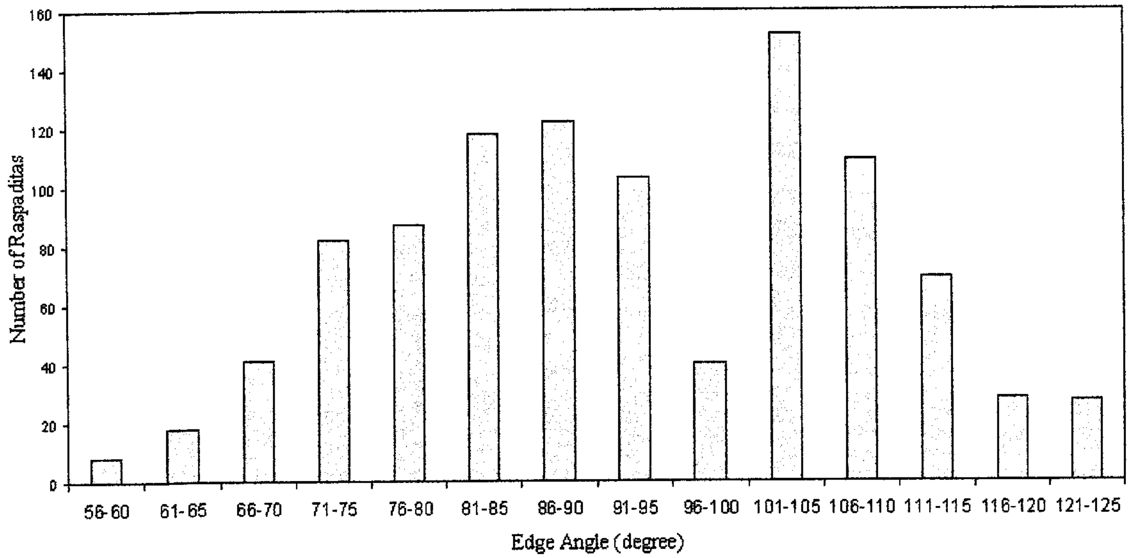


Figure 6.9 Histogram of raspadita edge angles.

6.21 Cluster Analysis

Cluster analysis was performed on all 698 complete tools collected in 2004. Cores, which were recorded in the field under the tool category, were not included. The tool types included in the cluster analysis are: axes, blades, bifaces, borer, choppers, drills, haftable blades, haftable knives, haftable scrapers, knives, multitools, perforators, projectile points, scrapers, spokeshaves, utilized flakes, utilized shatter (Figure 6.10).

The traits entered into the cluster analysis included length, width, thickness, edge angle, material type, retouch and use locale. Some of these are not numerical qualities, and as such had to be converted into binary terminology. All traits defining the raspadita tool class were given the value of 0, and the others were valued at 1(Table 6.3).

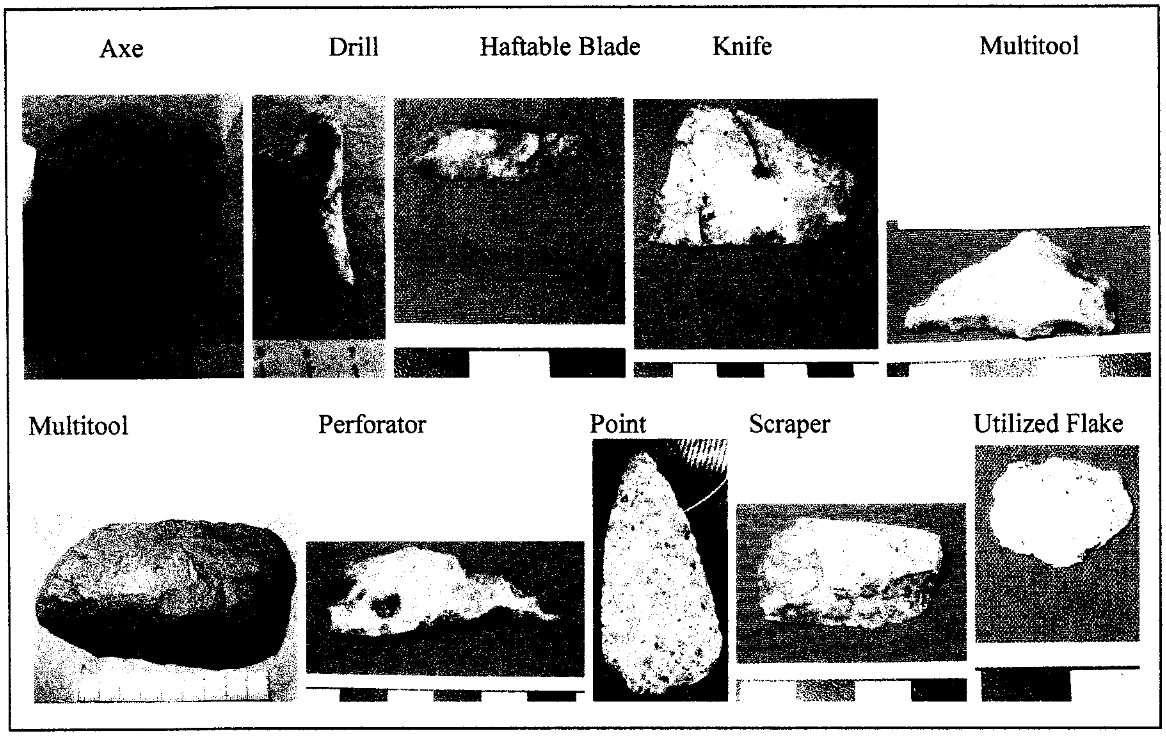


Figure 6.10 Tools types, other than raspaditas, included in dimension cluster analysis.

	Length	Width	Thickness	Facial	Rock type	Colour	Edge angle	Retouch	Retouch	Use locale
0	< 3 cm	< 2cm	< 1 cm	Uni	Chert	Light	60-130	Present	2 areas	2 areas
1	≥ 3 cm	≥ 2cm	≥ 1 cm	Bi	Non-chert	Dark	<60-130<	Absent	< 2 > areas	< 2 > areas

Table 6.3 Schematic for binary values for raspadita characteristics in lithic collection.

There is some redundancy in these categories as a result of the manner of recording the initial data. After several cluster analyses it became obvious that some groups should be joined and others removed. The material type and colour were joined into light coloured chert (0) or non-light coloured chert (1), as there were few non-chert or dark coloured cherts present. These different materials also appear more prevalent in some tool classes, such as bifaces, points, axes and choppers. The category separating those tool with 2 retouch areas from those with more or less retouch, eliminated the need for the division of retouched tools from non-retouched.

The first cluster analysis showed that one characteristic did not remove any artefacts from the main group, making its inclusion un-necessary. Therefore, to streamline the process the uni- and bi-facial tool category was removed. The remaining characteristics were tested to confirm that they provided unique information of some artefacts. This check was examined by running cluster analyses with the trait in question as the last one and then polling to see if the artefacts separated.

The remaining categories of separation light coloured chert, length, width, thickness, edge angle, use locale (2 areas), and retouch (2 areas) all separated some of the artefacts. Another set of cluster analyses were performed with the trait in question placed first and then polling to see if the artefacts separated at that level. This was to place traits with higher separation values first and lower values later to create fewer groups and groups with more similarities. The optimal order to separate the 2004 Santa Isabel lithic collection started with retouch (2 areas), edge angle, width, use locale (2 different), thickness, length, and light coloured chert (Figure 6.11).

Once the most effective way to separate the tools was determined, the next step was to rerun the cluster analysis. As all traits were converted into binary values, the higher the score of each tool the greater the difference from the raspadita tool class. Tools were grouped according to assigned type. Symmetrical and asymmetric raspaditas were treated as separate groups (Table 6.4). Multitools and bifaces were the closest to the raspaditas averaging just over one difference, while utilized flakes and shatter were the most different.

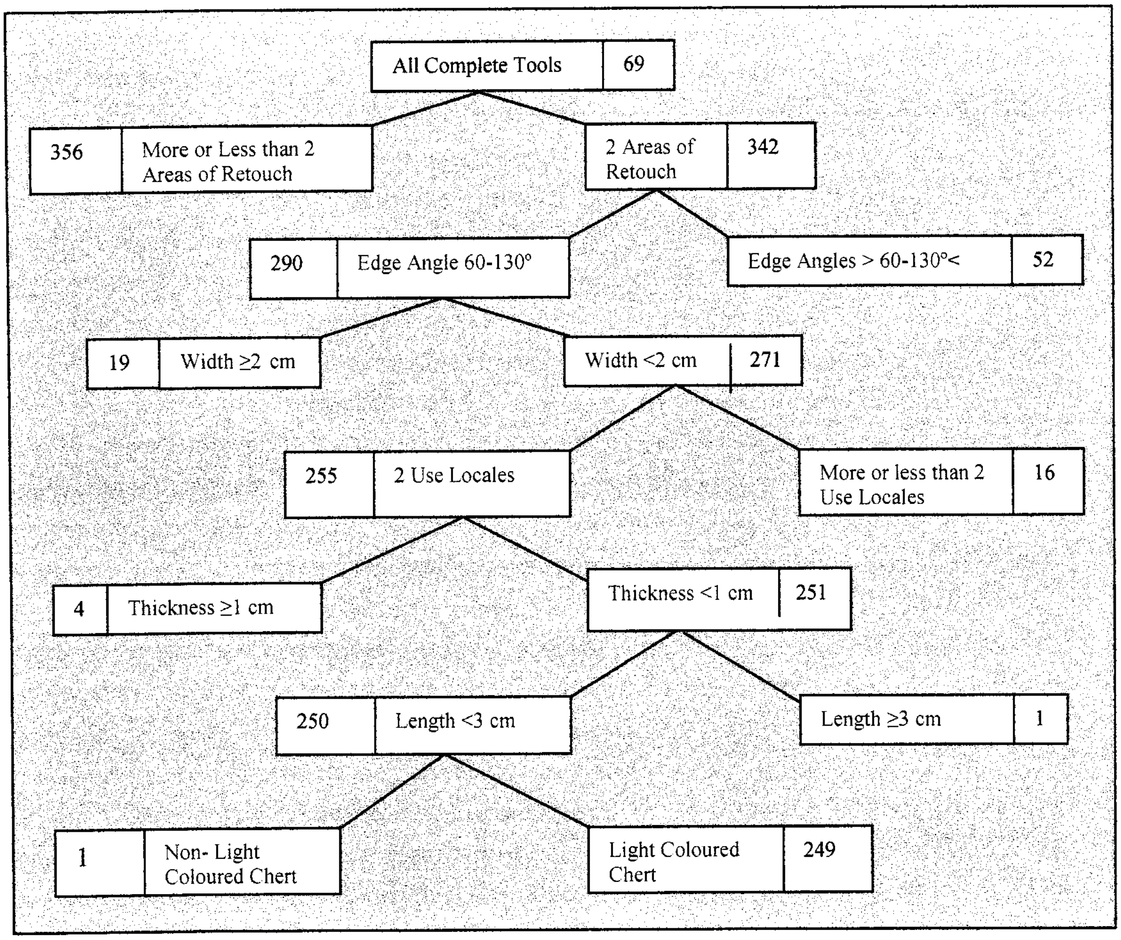


Figure 6.11 Efficient separation of raspaditas from other tools. Note blue text indicates raspadita traits and red are characteristics that fall outside of the range of raspadita variability. The numbers are tools separated by this characteristic. I.e. Width (< 2cm) separates a group of 271 into two groups one of 255 and the other 16.

Tool type	2 Retouch areas	Edge angle 60-130	Width	#Use locales	Thick-ness	Length	Chert/ non	Light/ dark	Uni/ biface	Retouch	Total Differences	Total Tools	Average per tool
Symmetric Raspaditas	0	0	0	0	0	0	0	0	0	0	0	244	0
Asymmetric Raspaditas	0	2	0	0	0	0	0	0	0	0	2	7	0.29
Haftable blades	1	1	0	0	0	1	1	0	0	0	4	3	1.33
Haftable scrapers	0	0	3	1	3	3	0	0	0	1	11	8	1.38
Spoke shaves	3	0	0	0	1	0	0	0	0	1	5	3	1.66
Haftable knifes	0	23	6	0	3	6	2	0	0	2	42	24	1.75
Total scrapers	88	2	25	24	11	18	20	4	5	15	202	110	1.84
Blades	21	11	6	1	1	1	4	0	19	1	65	21	3.10
Perforators	15	16	0	16	1	1	2	0	0	0	51	16	3.19
Util. Shatters	2	0	2	0	0	0	0	0	2	1	7	2	3.5
Borers	22	22	4	22	4	4	2	0	0	1	81	22	3.68
Knifes	12	14	9	1	6	3	2	0	0	6	53	14	3.79
Drills	30	31	1	31	0	4	1	0	0	7	105	31	3.87
Biface points	2	0	10	0	11	7	12	3	15	14	74	15	4.93
Choppers	0	0	4	0	4	4	3	3	0	3	21	4	5.25
Util. Flakes	152	88	93	152	17	22	8	1	152	152	837	152	5.51
Axes	0	1	5	1	5	5	4	4	0	3	28	5	5.6
Multitools	0	2	2	2	2	2	0	0	0	2	12	2	6.00
Bifaces	8	13	14	12	7	11	10	2	0	14	91	15	6.07

Table 6.4 Tool class differences. Note each cell contains the number of tools out of 698, which differ; the far right column contains the averages for each tool class.

All symmetric raspaditas obtained a value of 0 and were grouped together during the cluster analysis. Of the seven asymmetric raspaditas five clustered with the symmetric raspaditas, but the other two varied from the group because of their edge angles. This gave the asymmetric raspadita category a positive difference value of 0.29. When the average differences were plotted four groups are created (Figure 6.12). These four groups represent the major groups formed during the cluster analysis. Tools with large variation in numbers of differences had members that were occasionally placed in an adjacent groups, this is a result of large variation within the tool type itself. E.g. the total scraper category which includes both unifacial and bifacial tools, haftable and non-haftable pieces, and both side and end scrapers.

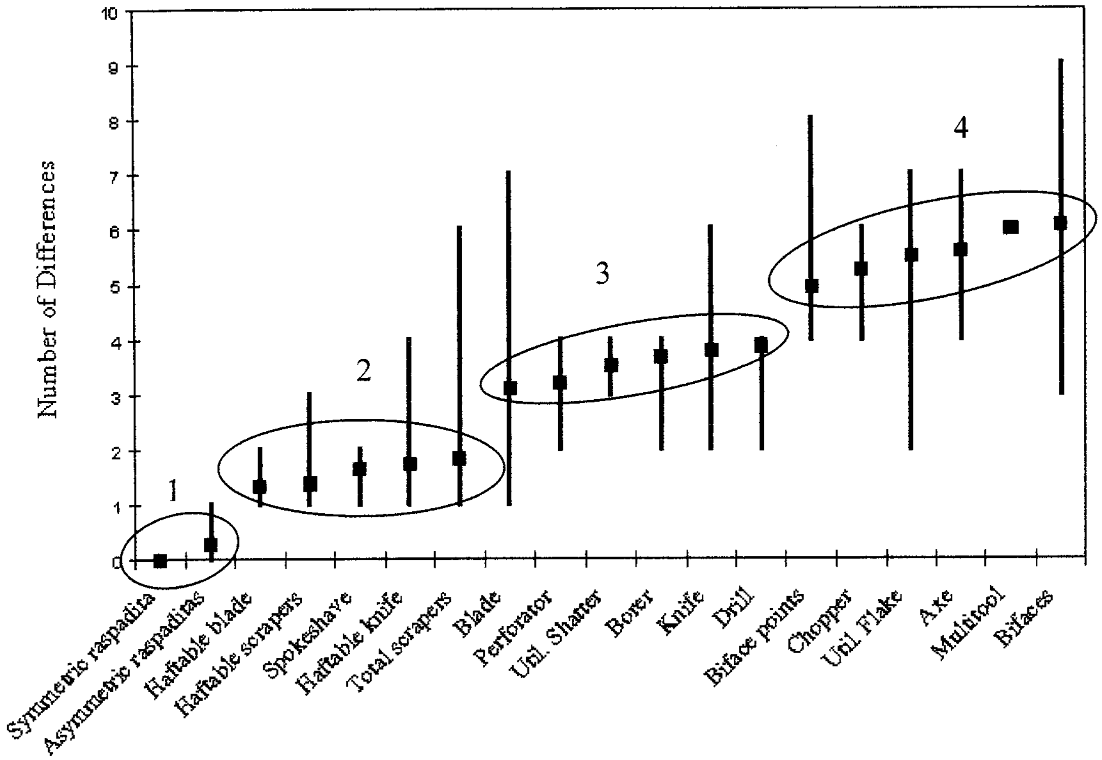


Figure 6.12 Range (highest and lowest values for that tool classes) and average differences for tool classes. Group 1 includes averages below 1. Group 2 includes averages between 1 and 2. Group 3 includes averages between 3 and 4. Group 4 includes averages between 4.9 and 6.2.

6.3 Manufacture Analysis

The platform at the proximal end contains 1 to 2 platform scars and is ovate/ plano-convex to triangular (Table 6.5). Most raspaditas, even those without remnant platforms, contain bulbs of percussion (Figure 6.13). These bulbs are quite defused and contain no bulbar fissures or eraillure scars, though this maybe a result of the mechanical properties of this chert (Odell 1981, Luedtke 1992). The platforms, which range in size from 4.2 mm to 2.9 mm in length and 2.4 mm to 1.5 mm in width, are often associated with lips. These characteristics point to soft hammer flake detachment (Andersky 1998, Kooyman 2000).

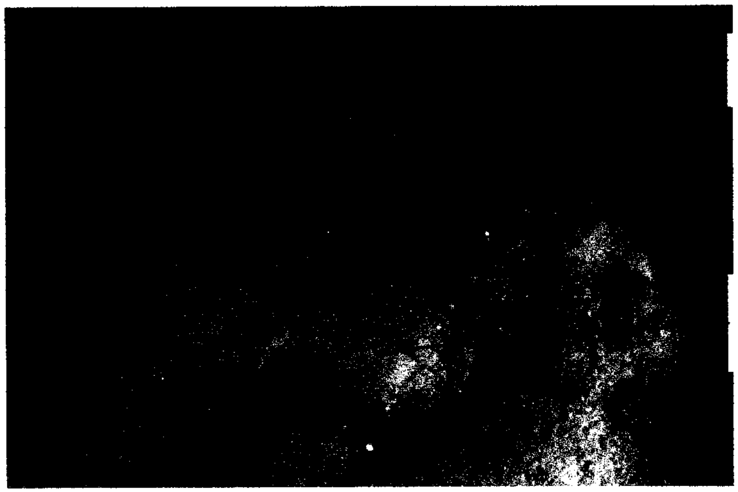


Figure 6.13 Raspadita manufacture characteristics.

	Platform						Bulb of Percussion			
Raspadita RI.44.	**Shape**	**Length (mm)**	**Width (mm)**	**Scars**	**Impact**	**Lip**	**Prominence**	**Bulbar fissures**	**Eraillure scars**	**Ripple marks**
04.2.285	Ovate	3.1	1.9	2	No	Yes	Diffuse	No	No	No
04.4.358	Ovate	2.9	2.1	1	No	No	Diffuse	No	No	No
04.1.385	Tri-angular	3.6	1.5	1	No	Yes	Diffuse	No	No	No
04.4.821	Tri-angular	3.2	2.3	1	No	Yes	Diffuse	No	No	No
04.4.602	Ovate	3.9	2.4	2	No	Yes	Diffuse	No	No	No
03.126.9	Tri-angular	3.2	1.7	2	No	Yes	Diffuse	No	No	No
04.4.173	Ovate	3.4	2.2	1	No	Yes	Diffuse	No	No	No
04.4.126	Ovate	3.8	1.8	2	No	Yes	Diffuse	No	No	No
04.2.360	Ovate	4.2	2.1	1	No	No	Diffuse	No	No	No
04.1.401	Tri-angular	3.8	2.0	2	No	Yes	Diffuse	No	No	No

Table 6.5 Observed manufacture characteristics of ten complete platform containing raspaditas. Note RI.44.04.4.126 an asymmetric raspadita shows no manufacture differences from the symmetric tools.

The raspaditas were manufactured using unifacial retouch. This retouch has removed any trace of the original termination from the distal end. The retouch is generally confined to the proximal ends and distal tips of the raspaditas. The midsection of the tools contains few retouch scars. Even the proximal ends in several examples contain few manufacture scars, implying that the blank was designed to be close to the raspadita form. The retouch flake scars on the distal tip and proximal end range in size from 5.3 mm to 3.1 mm. The scars are generally short, wide, feather terminating and relatively shallow indicating a pressure flaking removal strategy (Odell 1981, Andrefsky 1998, Kooyman 2000).

Fifty-eight blade or bladelet cores, that were the appropriate size and material for the raspaditas, were found in 2004 (Figure 6.14A). 119 of the 323 total non-blade cores[1]

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[1] This number is probably inflated due to core breakage.

could be a possible source of the raspaditas (Figure 6.14B). Though these cores are not uniform in shape, flake removal location, or flake size, it is possible that the flakes removed from these cores could be retouched into raspaditas. It is more likely, however, that the cores used to produce raspaditas were prepared and the removal of flakes organized so that the resulting blanks would be uniform and require limited retouch. As the raspaditas show little retouch and are uniform in form and size, it is more likely that they were produced on blade or bladelet core, which were prepared to produce uniform flakes.

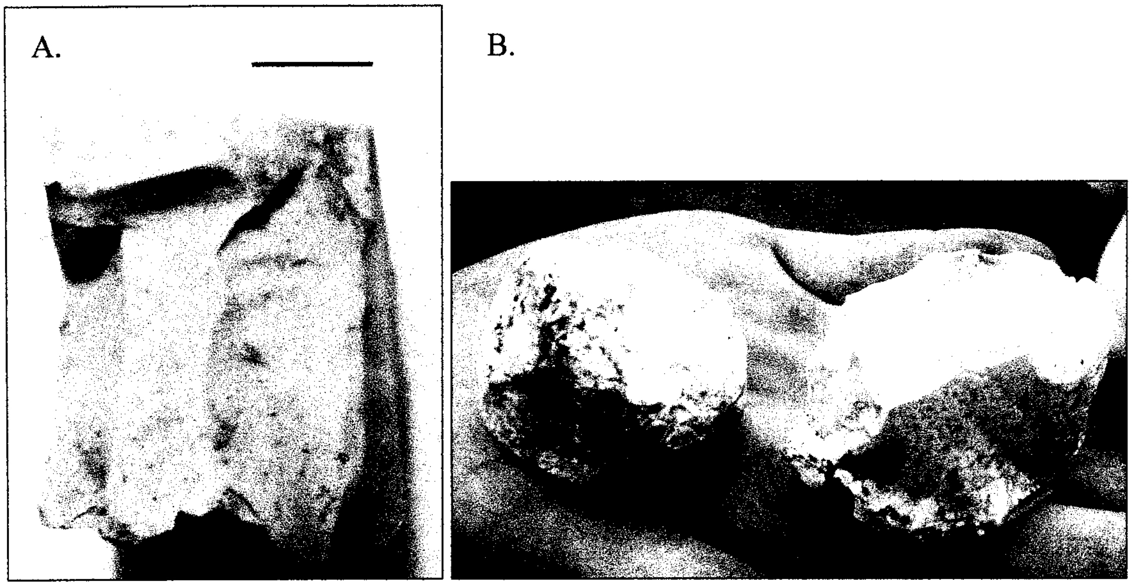

Figure 6.14 White chert cores from Santa Isabel. (A.) Bladelet core. Note it contains a termination and parts of a prepared platform. Scale bar is 1 cm. (B.) Nodule and nodule core. Note: Termination is present, but there is no regular platform.

The colour of the chert including the inclusions was recorded for all of the tools collected in 2004. The symmetric and asymmetric raspaditas were made entirely of white and pinkish white chert with inclusions. The white chert class was initially broken into small classes based on matrix shades. However, once analysed, these classes became irrelevant, since there was a gradation between shades. The category of pinkish white chert was retained as it is associated with an increased lustre in the raspaditas and in the other tools from 2004. When all of the tools are compared, the raspaditas have the highest percent of white chert (Figure 6.16). The category of pinkish chert is evenly distributed throughout the total tool collection. Raspadita, RI.44.03.1187.2, is pink throughout with pot-lidding and a black stain on one side (Figure 6.17). These characteristics suggest that this raspadita was heat-treated.

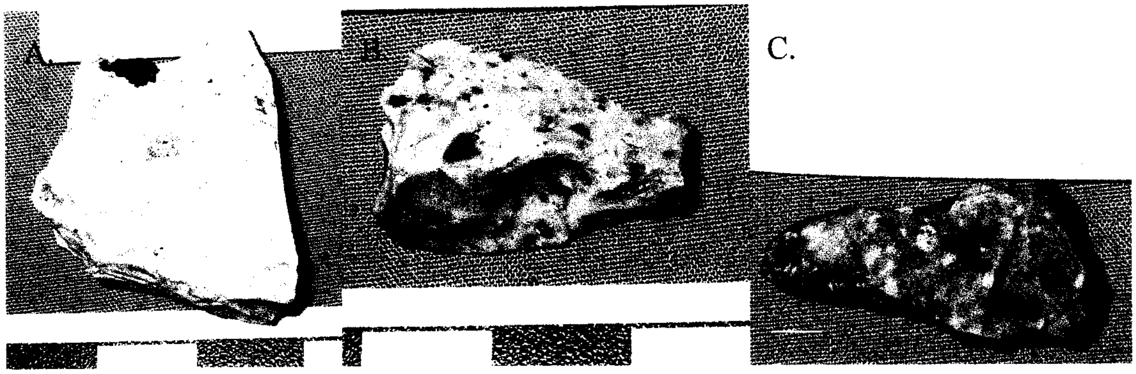

Figure 6.15 White, pinkish white, and pink chert colour classes. (A.) Shatter in white chert. Note darker inclusion. (B.) Haftable end scraper in pinkish white chert. Note increased lustre on dorsal ridge. (C.) Borer in pink chert. Note matrix is completely pink and scale bar is 1 cm.

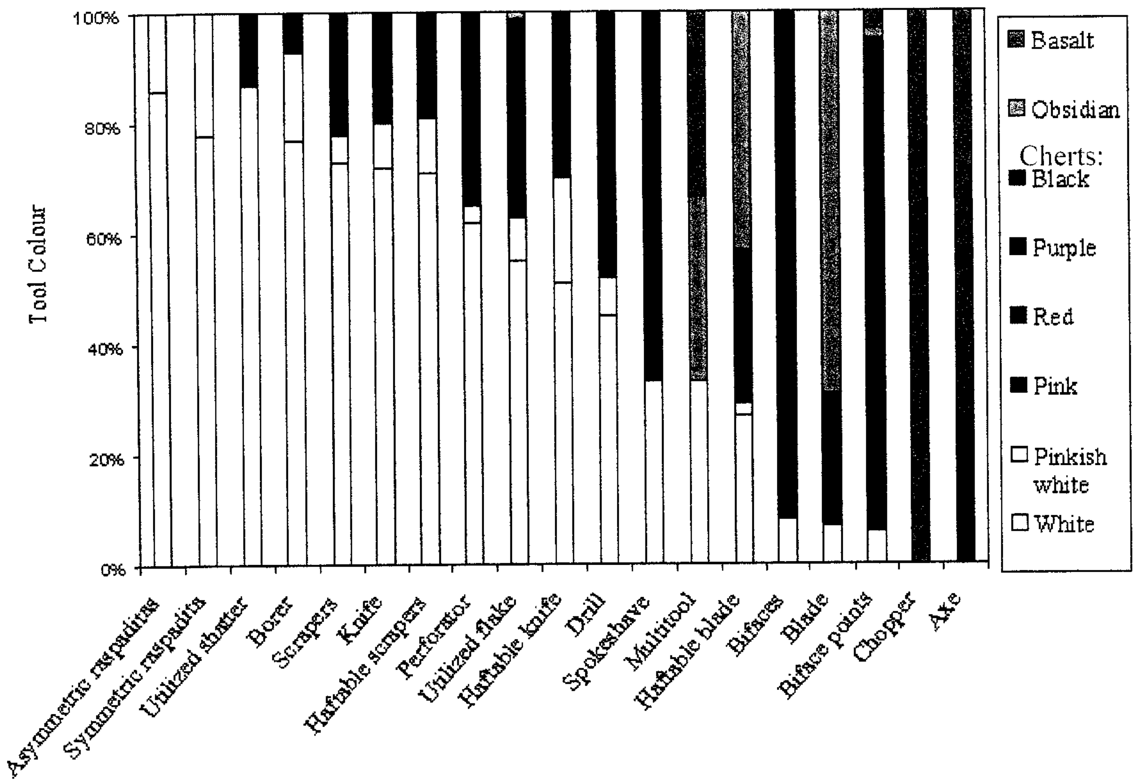

Figure: 6.16 Percent of material types for each lithic tool class

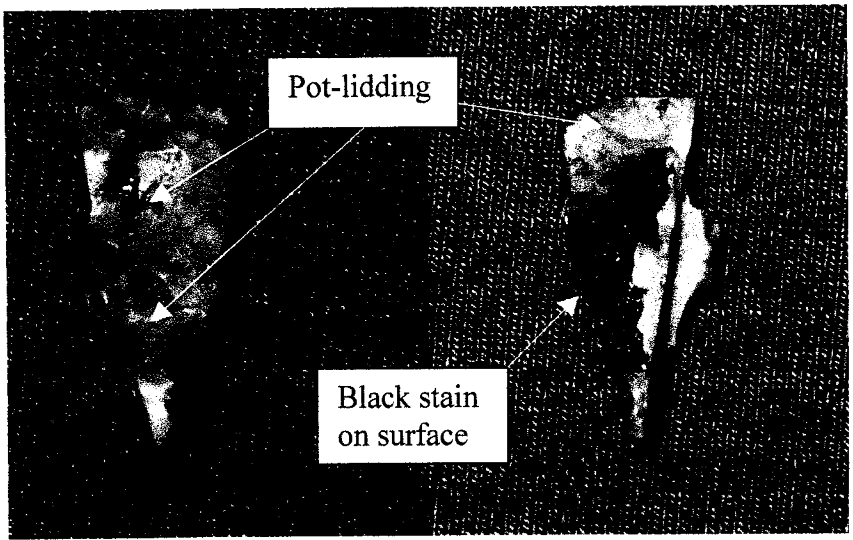

Figure 6.17: Possible evidence of heat-treating on RI.44.03.1187.2 a raspadita.

6.4 Usewear Analysis

A x10 hand lens was used in the field to examine the use locales of the raspaditas collected in 2004. Low power microscopy was used to confirm that the raspaditas selected for usewear analysis were complete and unbroken. The detailed analysis utilized scanning electron microscopy (SEM) with magnification ranging from 20x to 7000x. Not all types of usewear found in the literature are observable with SEM. Some of the polish characteristics such as reflectiveness cannot be compared with SEM since the samples are coated with gold to prevent charging of the surface. Therefore, it is necessary to define the classification of microwear categories used in the raspadita study.

The location of the microwear was recorded first as tip, midsection or end, and then as dorsal or ventral side. Since each tool was secured to a disk, usually only the ventral or dorsal side was visible. The microwear discernible in each of these sections was recorded independently. At low magnification, macrochipping (1-3mm) could be seen and was recorded as present or absent. Gradually, the magnification was increased and the additional usewear became visible and was recorded as present or absent. The types of microwear documented include microchipping (<1mm) (ridge, edge, spot or stepped), rounding (ridge, edge or spot), polish (ridge, edge or spot), striations (parallel, perpendicular or transverse to edge), striations (edge, or ridge), pits (present or absent), and residues (fibrous or ovate).

Thirty tools were examined using SEM, including four non-raspaditas for comparison: i.e. a tanged point, a broken end scraper, a drill and a perforator (Figure 6.18). The usewear visible on these four tools is substantially different from that observed on the raspaditas and supports their assigned functions (Table 6.6).

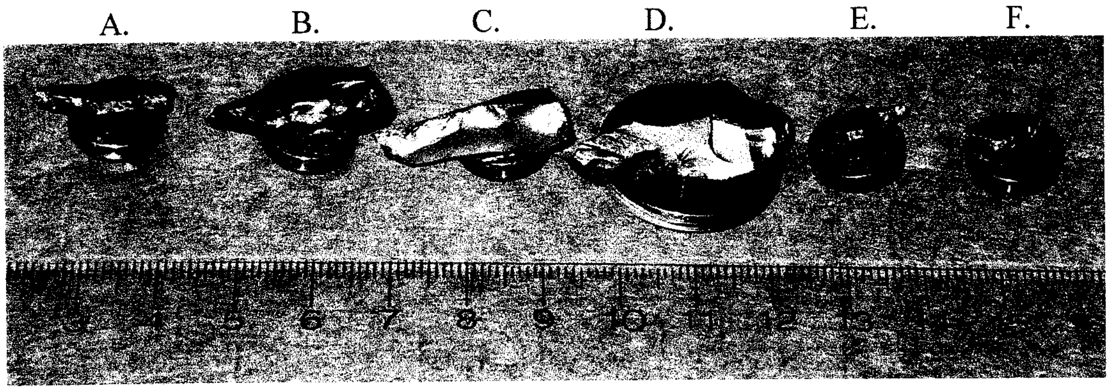

Figure 6.18 Tools prepared for SEM analysis. (A.) Tanged point. Note tang is right and point is left. (B.) End scraper. Note longitudinal break was placed down and used surface up. (C.) Perforator. Note tool contains a prominent arris, therefore only half of the dorsal side was secured to stub. (D.) Drill. Note ventral side is down. (E.) Symmetric raspadita. Note dorsal side is down. (F.) Asymmetric raspadita. Note ventral side is down.

The 24 raspaditas that were examined under the SEM included symmetrical samples of varying lengths and six asymmetric raspaditas, on which the convex end surface is not perpendicular to length (Figure 6.19, 6.4), but is off set slightly to the right or the left (defined as viewed from the ventral surface with proximal end up). The degree of angular asymmetry was usually no more than 20°, but sufficient for them to be analysed separately to see if their usewear was distinguishable from the symmetric raspaditas.

	End Use wear %										
Tools	**Striations**				**Chipping**			**Polish**		**Rounding**	
	″	⊥	≠	Comet	Micro	Step	Macro	Edge	Ridge	Edge	Ridge
Symmetric raspadita	0	85	5	5	100	20	45	100	100	100	100
Asymmetric raspadita	50	83	67	0	100	33	50	100	100	100	100
Tanged point	100	100	100	0	100	0	0	100	100	100	100
End scraper	0	0	0	0	100	100	100	100	100	100	100
Drill	0	0	0	0	100	0	0	100	100	100	100
Perforator	100	100	0	0	100	100	0	0	0	0	100

	Tip Usewear %									
Tools	**Striations**			**Chipping**			**Polish**		**Rounding**	
	″	⊥	≠	Micro	Step	Macro	Edge	Ridge	Edge	Ridge
Symmetric raspadita	5	15	15	85	30	55	25	25	95	90
Asymmetric raspadita	17	17	17	83	33	50	33	33	100	100
Tanged point	0	0	0	100	0	0	0	0	100	100
End scraper	0	100	100	100	0	0	100	100	100	100
Drill	0	100	0	100	100	100	100	100	100	100
Perforator	0	0	0	100	0	0	100	0	100	100

	Mid-section Usewear %									
Tool	**Striations**			**Chipping**			**Polish**		**Rounding**	
	″	⊥	≠	Micro	Step	Macro	Edge	Ridge	Edge	Ridge
Symmetric raspadita	2	0	0	60	20	25	15	15	45	30
Asymmetric raspadita	2	50	33	50	2	50	67	67	100	100
Tanged point	0	0	0	0	0	0	0	0	0	0
End scraper	0	100	0	100	0	100	100	100	100	100
Drill	0	100	100	100	100	0	0	100	100	100
Perforator	0	0	0	100	0	100	0	100	0	100

Table 6.6 Summary of usewear. Note comets are included in end usewear as they were only observed in this region. ″ Parallel, ⊥ Perpendicular, ≠Transverse to edge

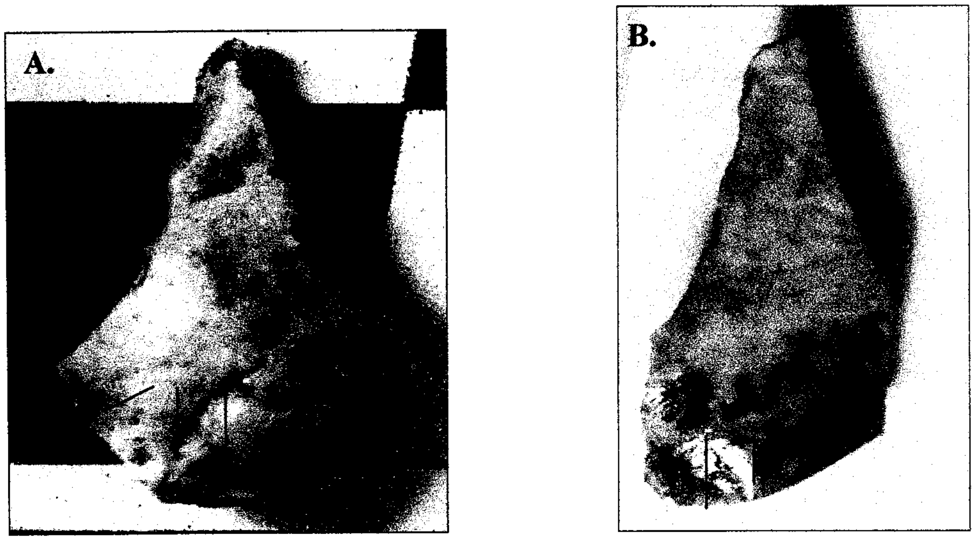

Figure 6.19 Striations on Raspaditas. (A.) Symmetric raspadita. Note striations are perpendicular to the edge. (B.) Asymmetric raspadita. Note striations perpendicular and transverse to edge.

6.41 Raspaditas

The raspaditas show considerable consistency in their usewear patterns. Microchipping is confined to and spread across the end in an equi-distant pattern on the dorsal edge. The majority of these microchips are normal, meaning feather terminating and ovate, though 33% of the asymmetric and 20% of the symmetric raspaditas have step-terminating microflaking (Figure 6.20). All asymmetric and symmetric raspaditas contained ventral end edge rounding and polish, as well as dorsal end ridge rounding and polish (Figure 6.21).

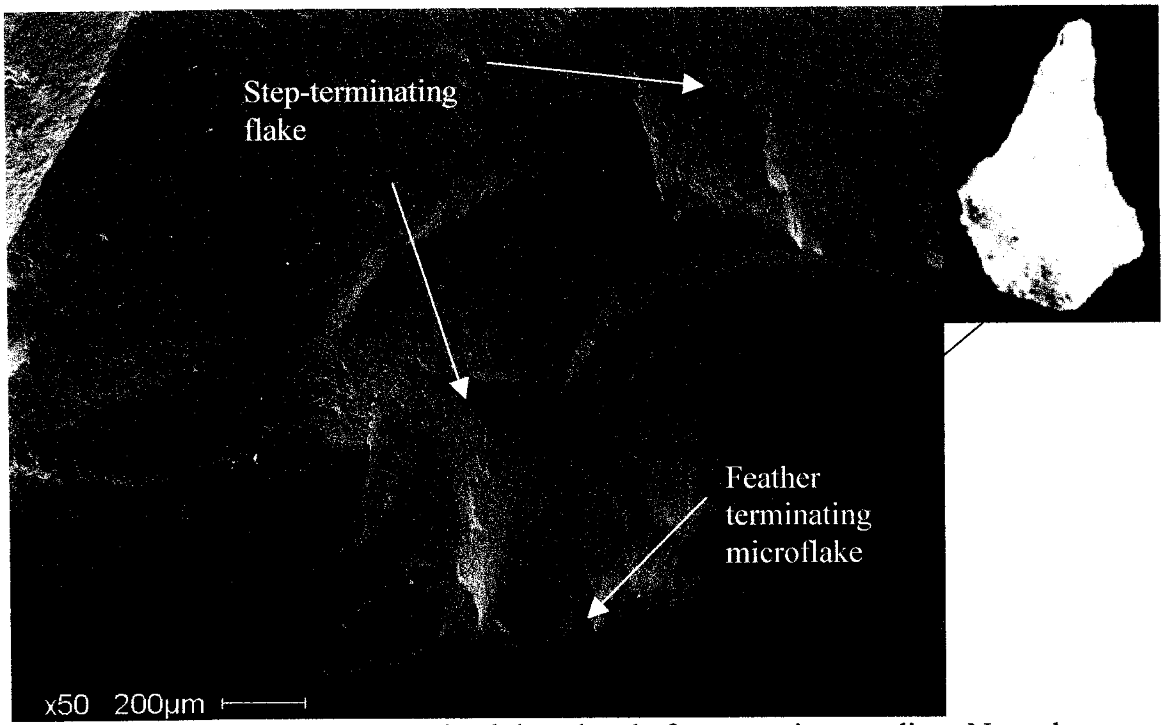

Figure 6.20 Microflaking on proximal dorsal end of symmetric raspaditas. Note abrupt termination of step-terminating flakes. The red arrow indicates location of the image on the raspadita.

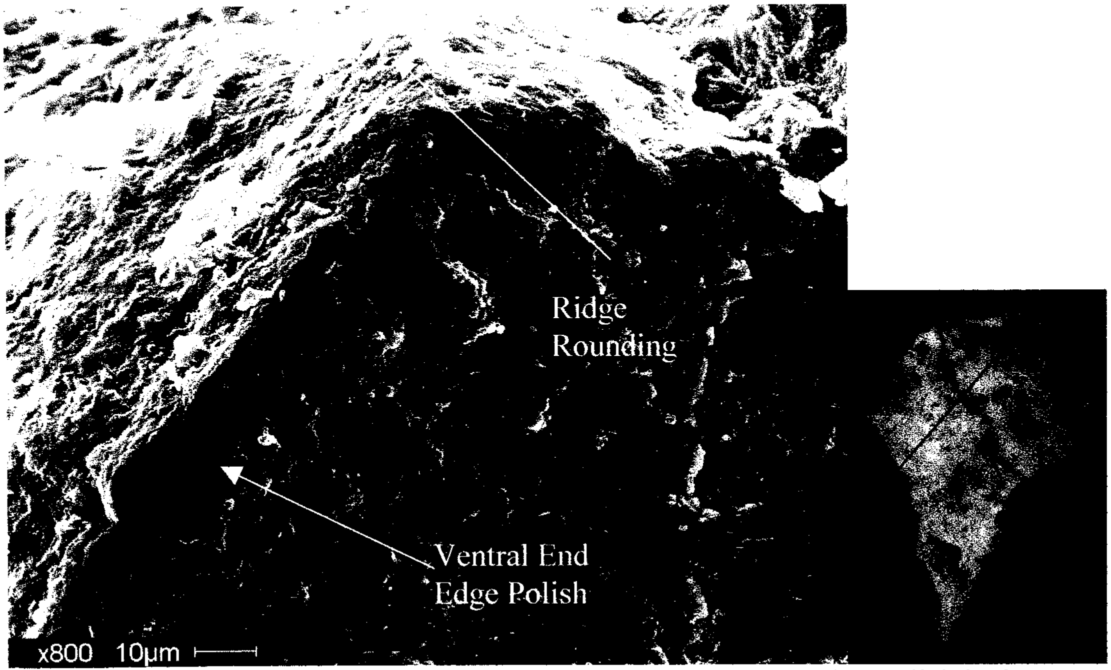

Figure 6.21 Usewear of symmetric raspadita. Note ventral end edge polish is the smooth dark band running along the edge. Note: Rounding involves limited smoothing but not to the extent of polish which removes all topography. The red arrow indicates the location of image on the raspadita.

Striations were perpendicular to the edge in the ventral end edge polish on 85% of the symmetric raspaditas and 83% of the asymmetric raspaditas (Figure 6.19 A, B). The ends of 50% of the asymmetric raspaditas also contain parallel striations and 67% have transverse striations (Figure 6.22, 6.23). The orientation of these striations could be a result of the tools asymmetry. The material makes contact with the asymmetric edge at an angle and as such creates striations at an angle other than 90° (Figure 6.19 A, B).

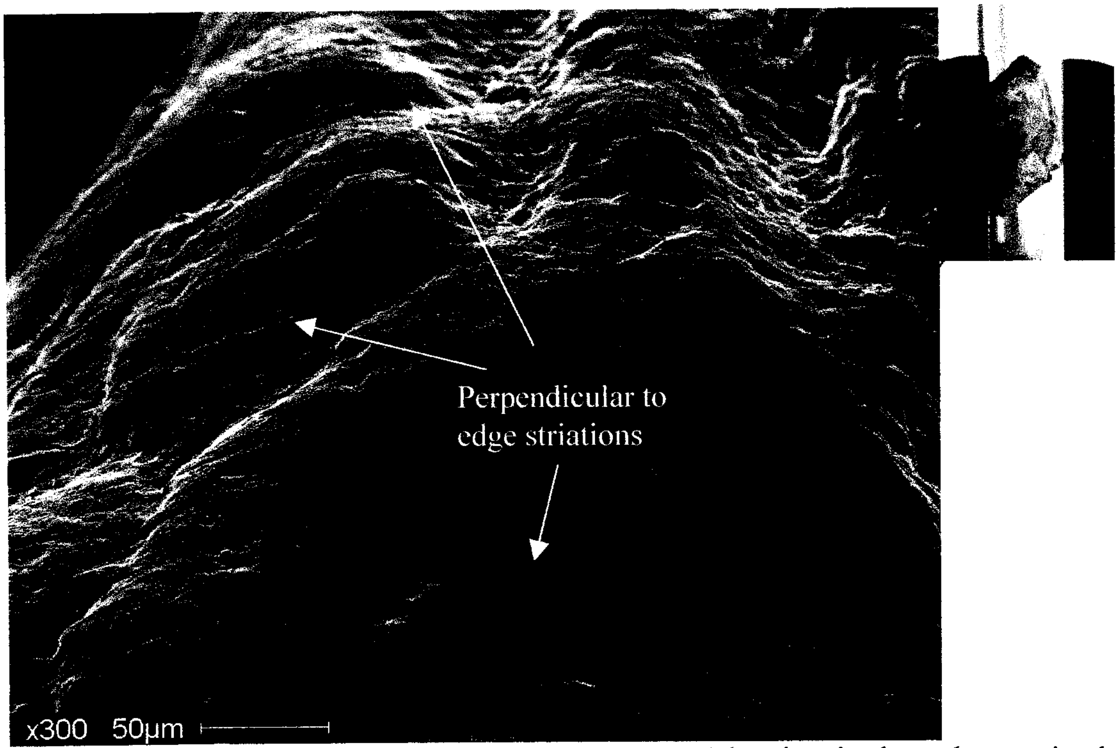

Figure 6.22 Striations on a symmetric raspadita. Note: The view is along the proximal ventral end edge and the dorsal side is on the left. The red arrow indicates the location of image on the proximal end of the raspadita.

The majority of microwear on the tip section of both the symmetric and asymmetric raspaditas consists of spot rounding and sporadic microchipping on ridges and edges, with about 1/3 containing step-terminating microflakes. Less than 20%, of both the symmetric and asymmetric raspaditas contained striations in areas containing spot polish and rounding (Figure 6.24). Microchipping was also distributed in a random pattern across the raspadita tips, but there seemed to be an inverse relationship between this and the formation of striations.

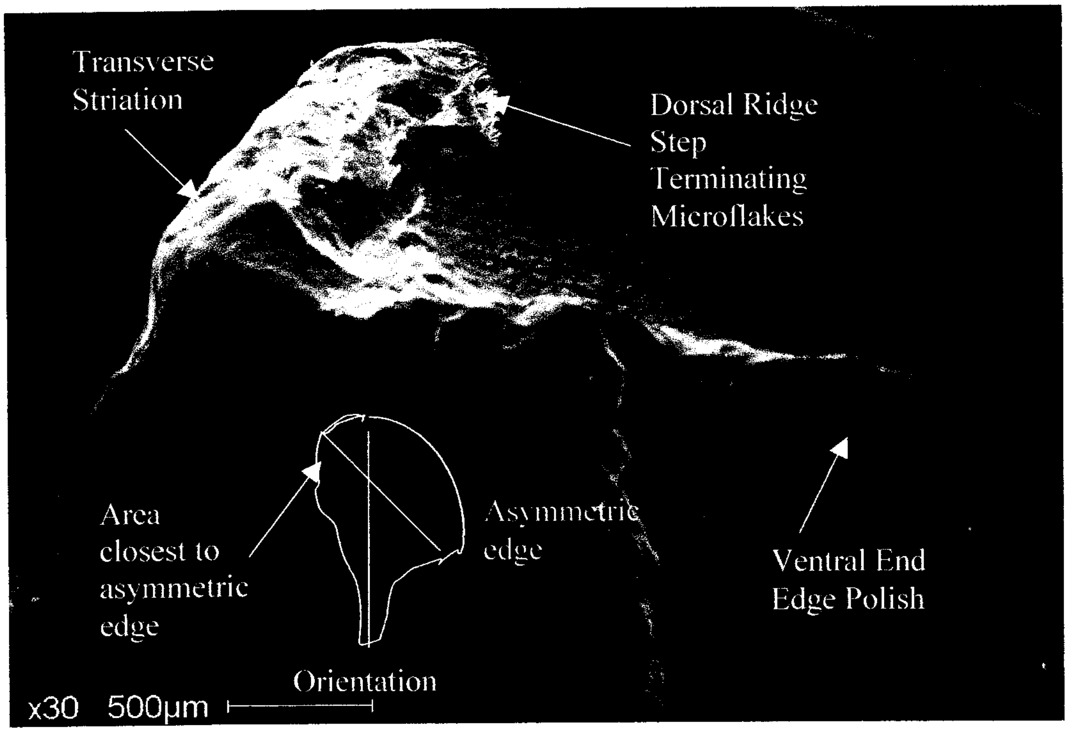

Figure 6.23 End microwear on asymmetric raspadita. Note the strong dorsal ridge, this is not common for asymmetric or symmetric raspaditas. The red arrow indicates location of image on the raspadita.

Microchipping was found on the mid-section of about 50% of symmetric raspaditas, but there was considerably more on the asymmetric raspaditas. On the side opposite the asymmetry, i.e. the right side of a left asymmetric raspadita (Figure 6.4 B), there was consistent ridge and edge rounding and 60% also had ventral edge and dorsal ridge polish. The area closest to the asymmetric end edge surface contained similar wear patterns to the end edge, though the orientations of the striations are often not perpendicular to the edge.

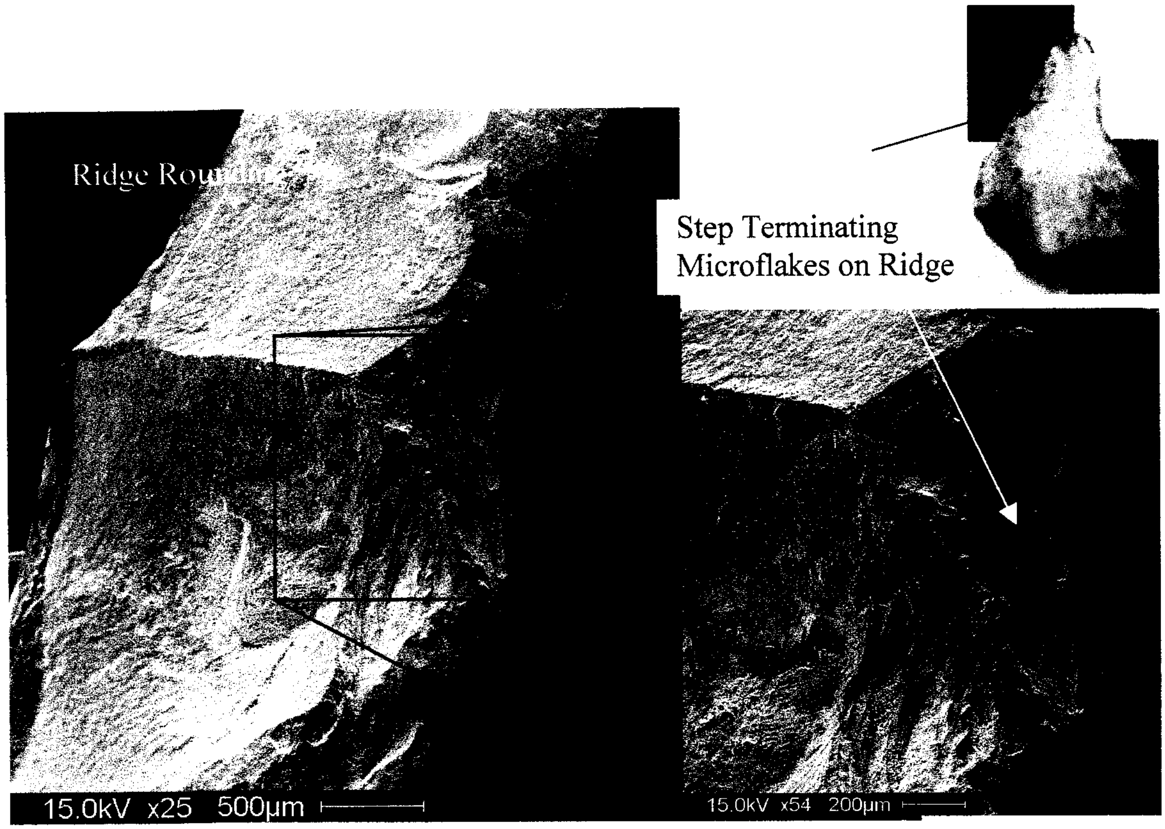

Figure 6.24 Symmetric raspadita tip microwear. Note sharpness of the dorsal ridge and lack of rounding on the flake scars. The red arrow indicates location of image on the raspadita.

Pits were found on most symmetric and asymmetric raspaditas (Figure 6.25 A, B). They appeared in all regions of the tools, including ventral/ dorsal sides, and areas with or without usewear. The pits ranged in diameter from a couple of microns to those discernable by the naked eye with variable depths. The interiors of some pits are relatively smooth (Figure 6.25 A), while others contain quartz crystals (Figure 6.25 B).

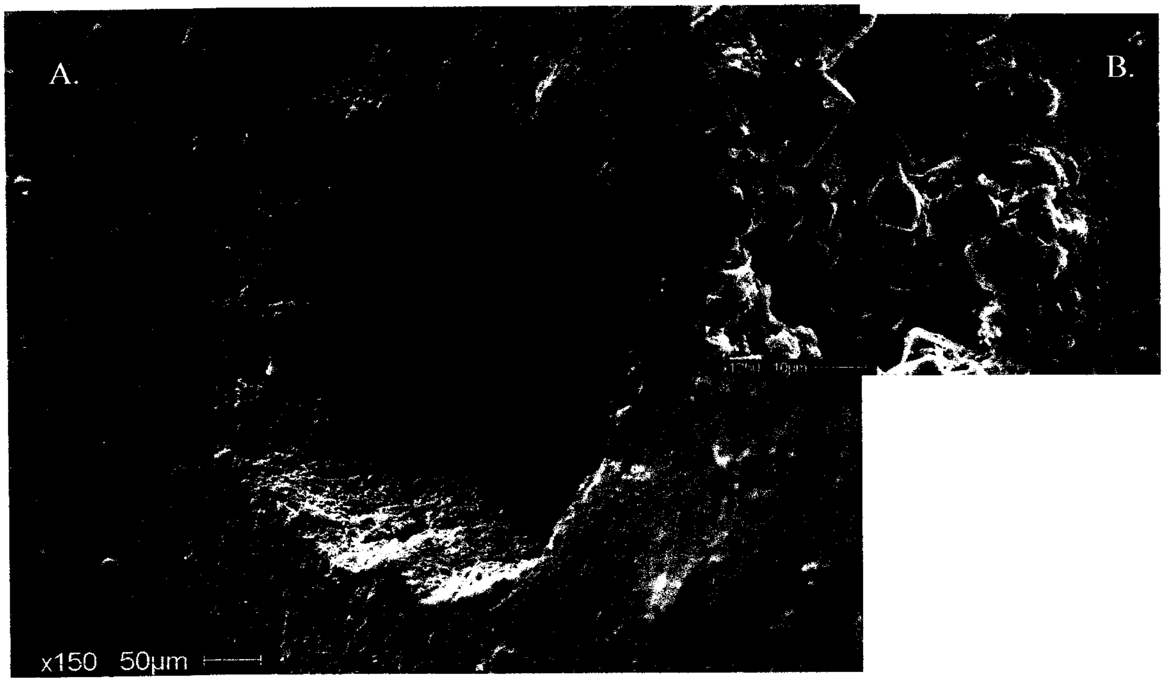

Figure 6.25 Pit features on the surface of raspaditas. (A.) The ventral midsection of an asymmetric raspadita. (B.) The ventral midsection of a symmetric raspadita. Note the occurrence of crystal inclusions or smooth interiors does not correlate to tool type.

6.42 Non-Raspaditas

Each of the non-raspadita tools was examined in the same way as the raspaditas being divided into end, tip and midsection. Spot polish, rounding and striations of different orientations, and sporadic microchipping were found on the hafts of the tanged points. This is similar to the usewear on the tip of the raspaditas (Figure 6.26, Table 6.6). The end of the drill contains spot and ridge rounding and polishing suggesting prehension or hafting (Yerkes 1983, Calley & Grace 1988). The perforator has only ridge rounding with a few random shallow microchips. The end scraper has similar usewear on its end, tip and midsection, including edge polish and rounding, ridge polish and rounding on both sides and striations perpendicular or transverse on both edges (Figure 6.27). Other scraper microwear in the form of micro and macrochipping was observed throughout the length of the tool. All this wear is confined to one side of the tool. The broken surface gives this end scraper a characteristic raspadita form but it does not contain any microwear.

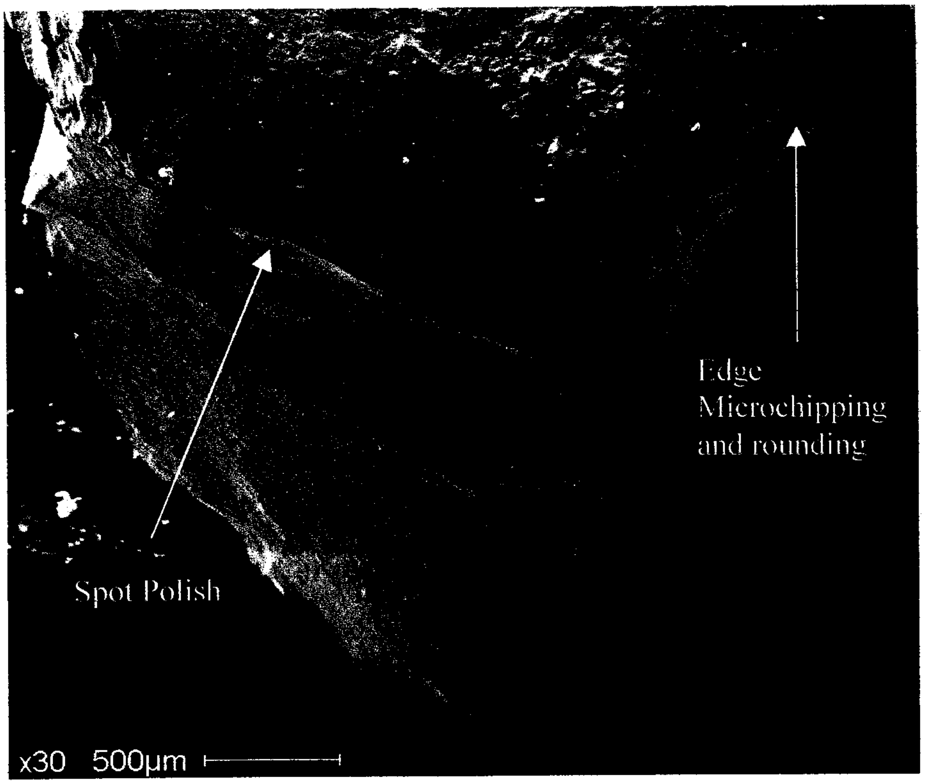

Figure 6.26 Usewear on tip of the tanged point. Note: ventral side is up.

The tip of the perforator and drill shows perpendicular to edge striations, ridge rounding and polishing, edge rounding and polishing, and microchipping. The only difference between the two tools is that the drill has microchipping on alternating edges, indicating a bidirectional or twisting motion (Yerkes 1983, Calley & Grace 1988), whereas the perforator does not (Figure 6.28). The tip of the tanged point has rounding and microchipping. The pits found on the raspaditas were also found on the end scraper and perforator but not on the drill or tanged point. The pits were not associated with usewear or morphological characteristic on any of these tools.

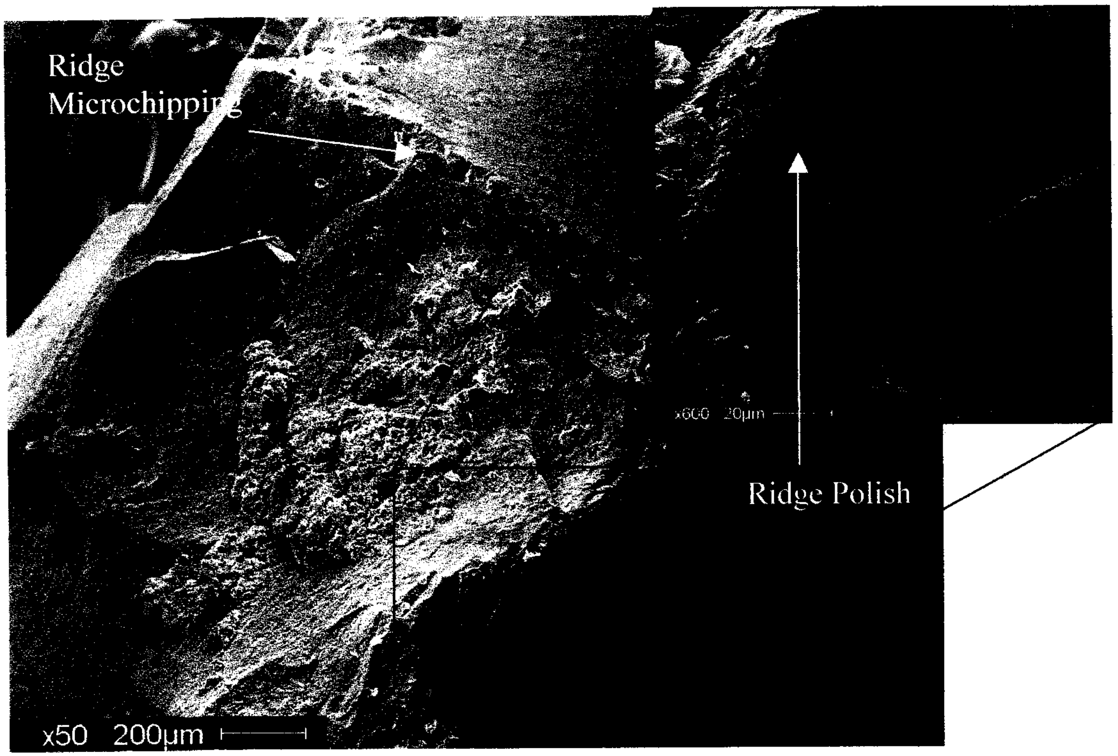

Figure 6.27 Usewear on end scraper midsection. Note dorsal view. Note similarities to raspadita end usewear in Figures 6.19- 6.22.

6.5 Lithic Residues

6.51 SEM Residue Analysis

Ovate and fibrous residues were found on the surface of the raspaditas using SEM. The tools had been thoroughly cleaned so particles that remained must have been securely attached to the surface. Ovate residues were found on the highly polished areas in use locales of 11 raspaditas. A fibrous residue covered large portions of one tool (Figure 6.29).

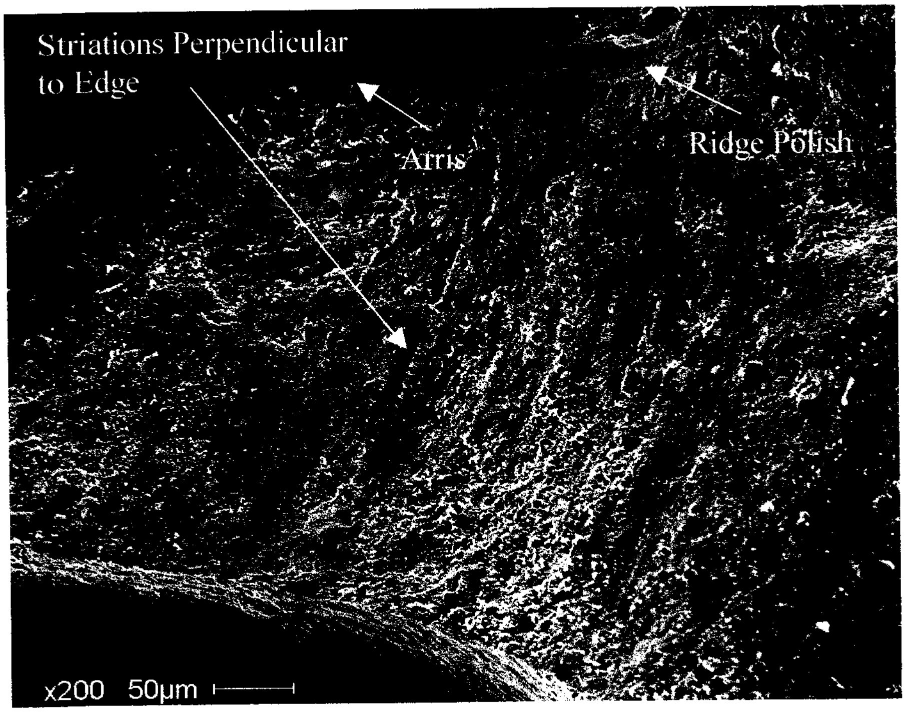

Figure 6.28 Usewear on the tip section of the drill. Note the dorsal side is up and the arris is prominent.

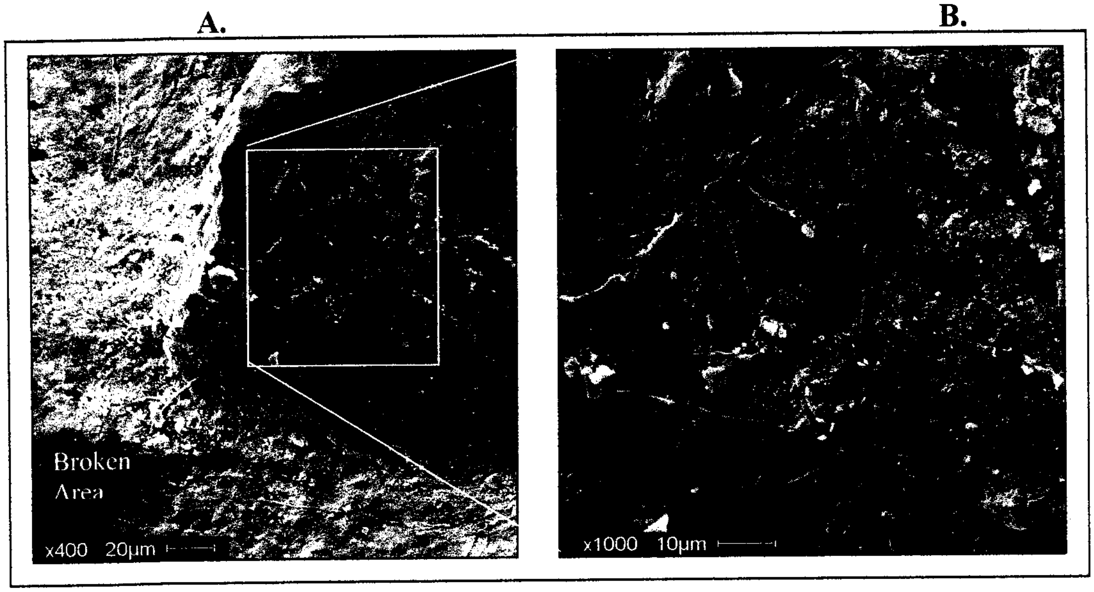

Figure 6.29 Fibrous residues on ventral end of a symmetric raspadita. (A.) Polished area with a broken surface. Note the rough texture and residues on the broken section on the left hand and bottom portions. (B.) A close up of the fibrous residues.

The fibrous residue has inter-connected fibres. It extends into regions without usewear (Figure 6.29A) covering most of the tool's surface; including a broken area of the ventral end polish. This indicates that it adhered to the surface after breakage. Since there is no sign of use after the breakage, the residue probably formed at the end of use, at discard or after deposition.

Ovate residues were found by SEM on 11 of the 26 raspaditas, including one asymmetric form. The ovate residues were classified in four different shapes: long-ovate (length $\geq$2x width), short-ovate (length $\approx$width), rectangular-ovate (square shaped edges) and crossed-shaped (rectangular with corners removed) (Figure 6.30). The size of the residues is 15-20 μm in length and 5-20 μm in width. All of these residues were restricted to the end use surface and were always associated with areas showing intensive usewear including polish.

Energy dispersion X-ray (EDX) analysis of the ovate residues showed no elements in addition to silicon from the chert or gold and palladium from the coating, but did show a slight increase in silicon counts, relative to the chert substrate. If these ovate structures were organic a drop in silicon counts would be expected, as EDX cannot detect elements lighter than fluorine. Therefore, the ovate residue appears to be composed of silica.

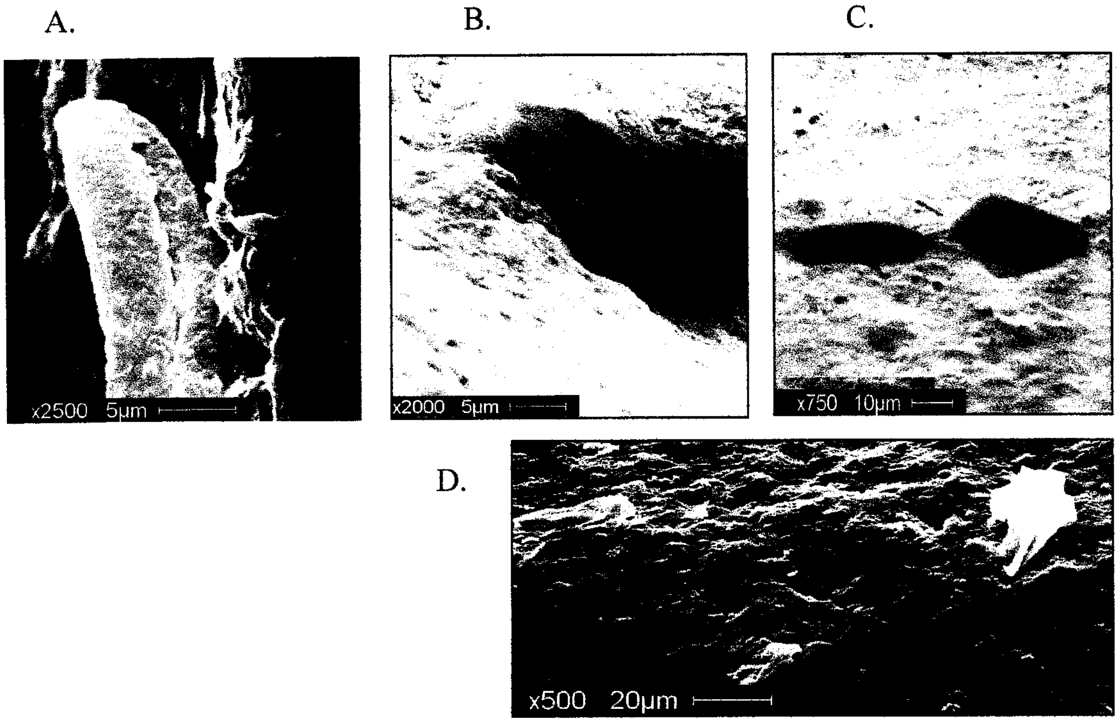

Figure 6.30 Ovate raspadita residues. (A.) Long-ovate residue embedded in ventral edge polish. (B.) Short-Ovate residue adhering to ventral end surface. (C.) Two rectangular-ovate residues in ventral end polish. (D.) Cross-shaped. Note ovate residues usually occur in groups, single images shown emphasize shape characteristics.

The ovate residues were only found in areas of intense usewear (Figure 6.31). Five of the eleven raspaditas that contained this ovate residue contained only the short-ovate type, four had the short-ovate and rectangular-ovate type, one contained the short-ovate and long-ovate type, and one had all four types of ovate residues. All these residues were found in depressions or along ridges, which probably helped them adhere to the surface during the intense cleaning. Over fifty individual ovate residues were found, generally clustering in groups larger than five.

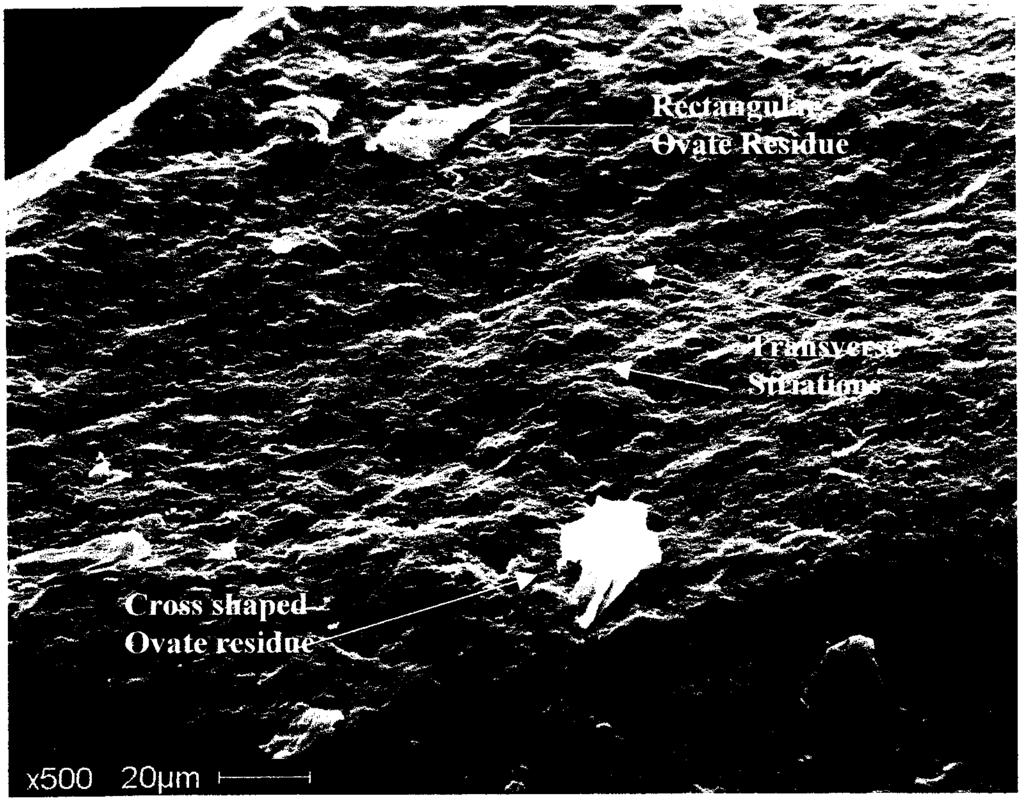

Figure 6.31 Ovate residues on an asymmetric raspadita ventral edge.

6.52 Extracted Residues

Three raspaditas were processed for residue extraction. Two tools produced several grains and one contained no observable residues. One tool contained one starch grain and one phytolith (Figure 6.32 A, B), whereas the other contained two starch grains (Figure 6.32 C, D).

The starch grains were identified due to their fibrous structure, which under cross-polarized light forms an extinction cross (Pearsall 1989). The starch grains are all approximately the same size, 4-5 µm in diameter. The identification of the type of starch grain requires a comparison with a reference collection (Pearsall 1989, Piperno & Pearsall 1998, Perry 2002), which was not available.

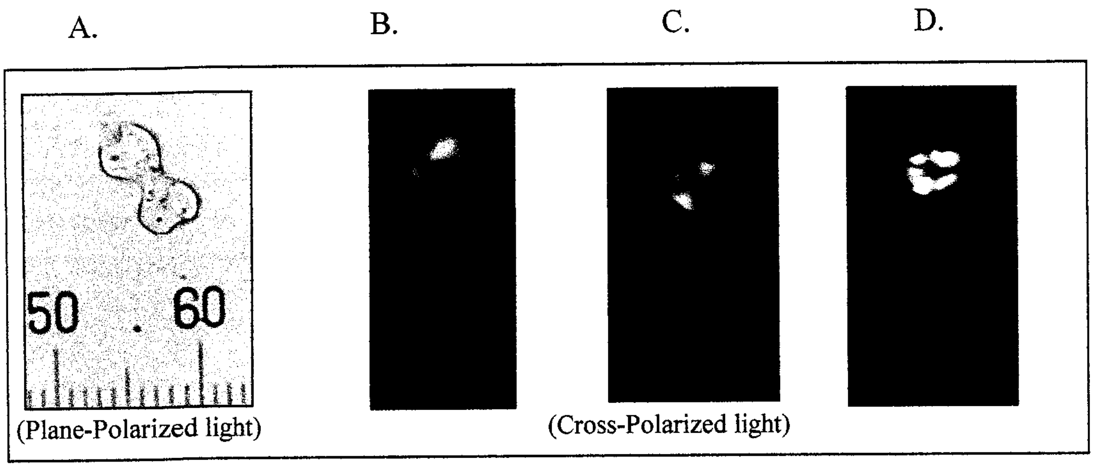

Figure 6.32 Residues extracted from symmetric raspaditas. (A.) Dumbbell shaped phytolith under plane-polarized light. (B.) Starch grain under cross-polarized light. (C.) Starch grain under cross-polarized light. (D.) Starch grain under cross-polarized light. Note the extinction crosses of the starch grains. Images by Ave Dersch.

The size and dumbbell shape of the phytolith indicate that it comes from a New World grass. Dumbbell shaped phytoliths are produced in both maize (*Zea mays)* and wild Panicoid grasses (Pearsall 1989, Piperno & Pearsall 1998). Therefore, this phytolith could only be identified as a grass.

6.6 Chert Sourcing

Samples of nodular chert, JD.01.04, were collected from the limestone of the Tertiary Barra Honda Formation (Figure 6.33). The locality was approximately 300 m west of the Rio Tempisque Bridge, by the town of Puerto Moreno, Costa Rica (N10°14.353, W085°15.148, elevation 38m). The limestone has alternating thick and thin beds with the chert nodules found in a thinly bedded layer (16cm thick). These calcareous sediments formed through the accumulation of microbiological organisms, and overly the Cambrian-Maasrichatian Rivas Formation.

Figure 6.33: Limestone, Barra Honda Formation.

Red chert (sample JD.02.04) was collected from thick (>60 cm) beds of Precambrian Basaltos Toleiticos ophiolitic basalt. The locality is close to the town of Chumico, Costa Rica (Figure 6.34) (N 10°22.380 W85°40.278, elevation of 77m). The outcrop also contained beds of ash and thinner beds of basalt. The basalts are generally fine grained with olivine and plagioclase phenocrysts. Radiolarites and xenoliths can also be found within this formation with minor siliceous and calcareous sediments.

Figure 6.34: Red ophiolitic chert. Scale bar is 5 cm.

Samples JD.03.04 of pink and brown chert were collected along the Pacific Ocean coast by the town of Bahia Brasilito, Costa Rica (N 10°25.130 W 085°417.623, elevation 45m). These samples of chert were collected from boulders and remnant outcrops of basalt along the sandy/pebble beach (Figure 6.35). The chert was in the form of nodules and was quite weathered. Some of the chert nodules appear white and pink but these colours were just a patina over dark red. The basaltic outcrop by Bahia Brasilito dates from Jurassic to Cretaceous and contains xenoliths. Radiolarites form lens <10cm of chert and chalcedony.

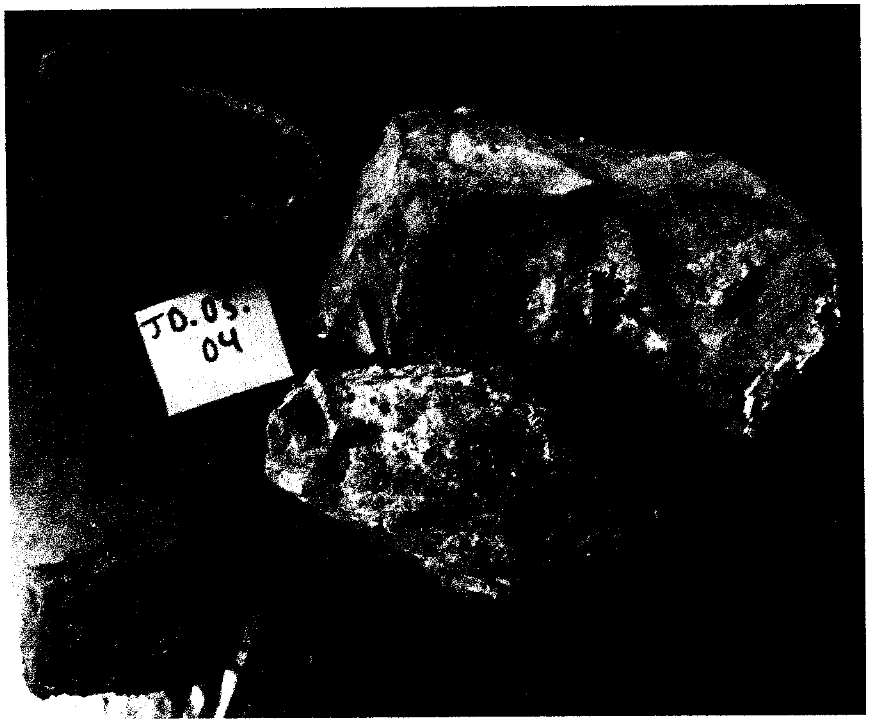

Figure 6.35: Red and brown nodule chert from Bahia Brasilito, Costa Rica. Scale bar is 5 cm.

Three samples of chert were collected at Punta Ple Del Gigante Beach, along the Nicaraguan Pacific coast (Figure 6.36). A dark grey chert (JD.04.04) was found in a lens of coarse-grained sandstone. A red nodular chert with inclusions was collected, from a thin sandstone bed just above the location of grey chert. Sample (JD.06.04) was taken from a 3cm thick bed of siliceous mudstone above the sandstone.

Figure 6.36: Chert samples from Punta Ple Del Gigante Beach, Nicaragua. (A.) Solid dark grey chert. (B.) Red nodule chert with inclusions. (C.) Bedded siliceous mudstone. Scale bar is 1 cm.

Samples (JD.07.04) were collected from Punta Majagual Beach, on the Pacific side of central Nicaragua (Figure 6.37) (N 11° 17.932 W085° 54.950, elevation 50m). The outcrop consisted of thin layers of limestone that were being eroded by wave action. A 15 cm thick conglomerate bed contained many nodules of chert, some of which were being eroded out. Samples collected consisted of a dark grey/ flint-like chert, white chert without inclusions and light grey chert with inclusions. The chert appeared to weather red, but non-weathered nodules were grey or white.

Samples JD.08.04 of purple and red chert were collected just outside Bocana El Coyol, on the Pacific coast of Nicaragua (N°11 35.363 W 86° 01.501, elevation 121 m. The outcrop consisted of limestone beds with a bed of conglomerate (Figure 6.38). The cherts contained macroscopically inclusions similar to those in the archaeological lithics.

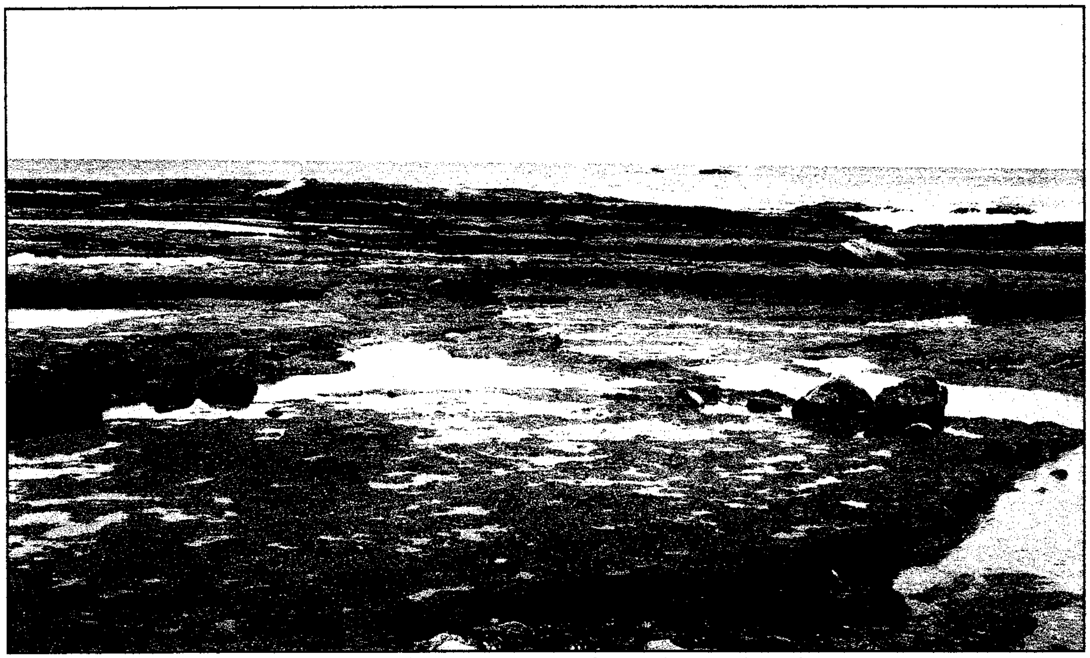

Figure 6.37: Chert conglomerate bed, Punta Majagual Beach, Nicaragua.

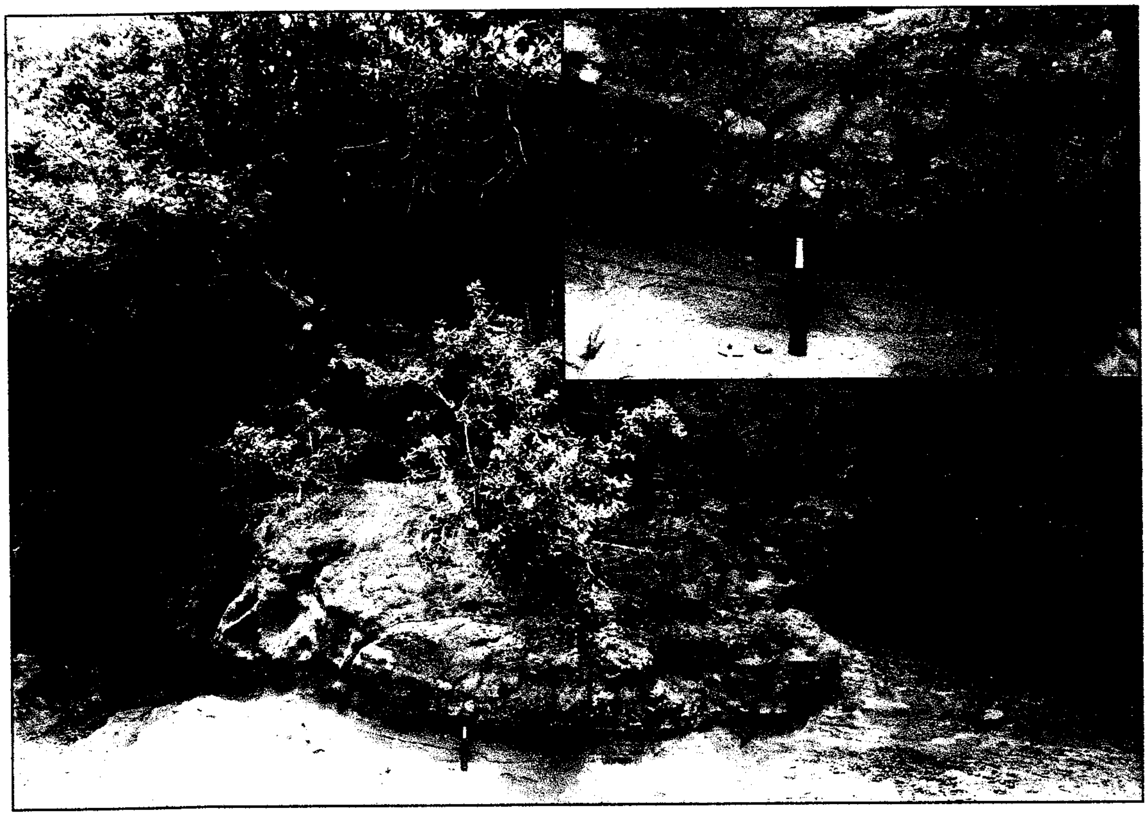

Figure 6.38: Bocana El Coyol, Nicaragua.

Samples (JD.09.04) of chert were collected from a conglomerate bed (Figure 6.39) on a beach just south of Bocana El Coyol (N 11° 29.075 W 086° 09.617, elevation 35m). This conglomerate bed was below thickly bedded sandstone and above thinly bedded sandstone, and is probably the result of a turbidite flow. These samples included pink, tan, light and medium grey chert with inclusions and white chert without inclusions.

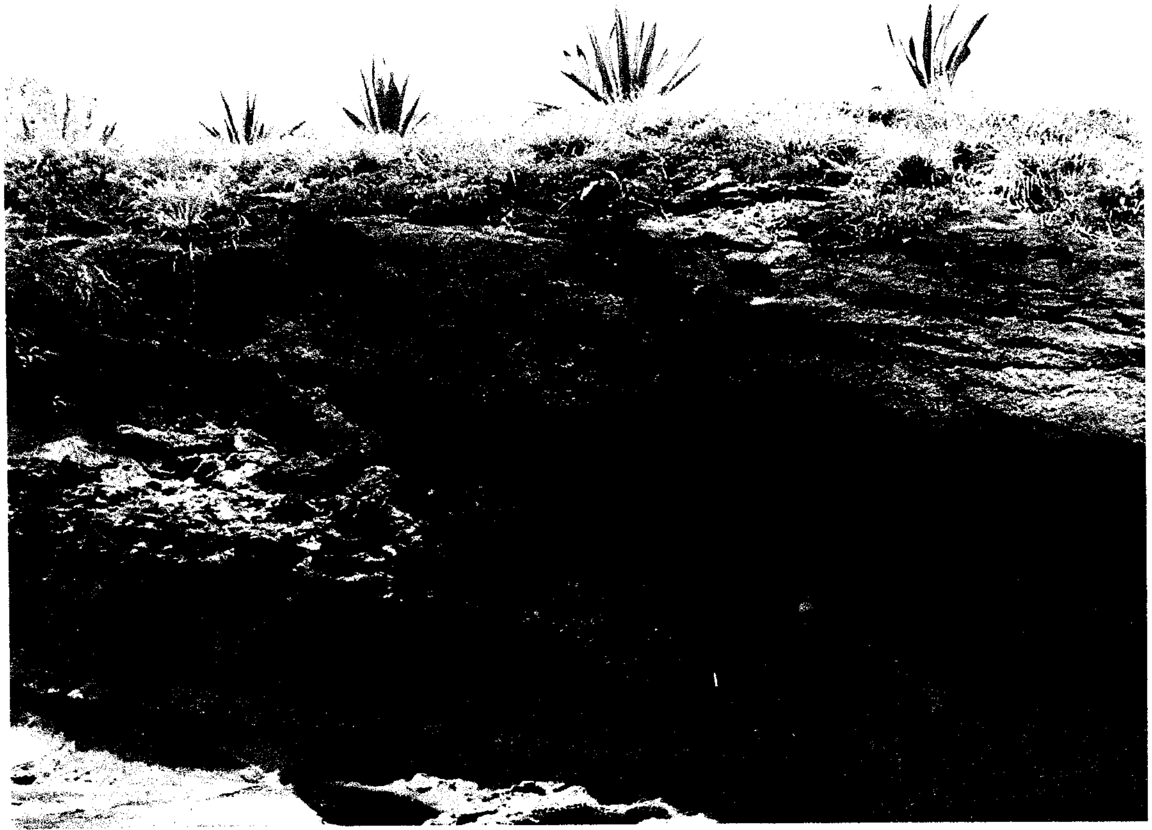

Figure 6.39: South of Bocana El Coyol, Nicaragua.

All Nicaraguan samples of chert were from the Tertiary Brito Formation, which unconformably overlies the Rivas Formation, as does the Las Palmas formation in Costa Rica. The Brito formation is a thick accumulation of Palaeocene to lower Eocene turbidites with shale and massive to bedded sandstone.

6.61 Optical Analysis

The raspaditas (RI.44.03.1636.25, RI.44.03.171.9, RI.44.03.1187.2) are made of white chert containing inclusions of quartz grains and of other chert fragments (Figure 6.40). Features visible under the microscope were circular opaque minerals and some brown staining possibly from iron oxides/hydroxides (Figure 6.41).

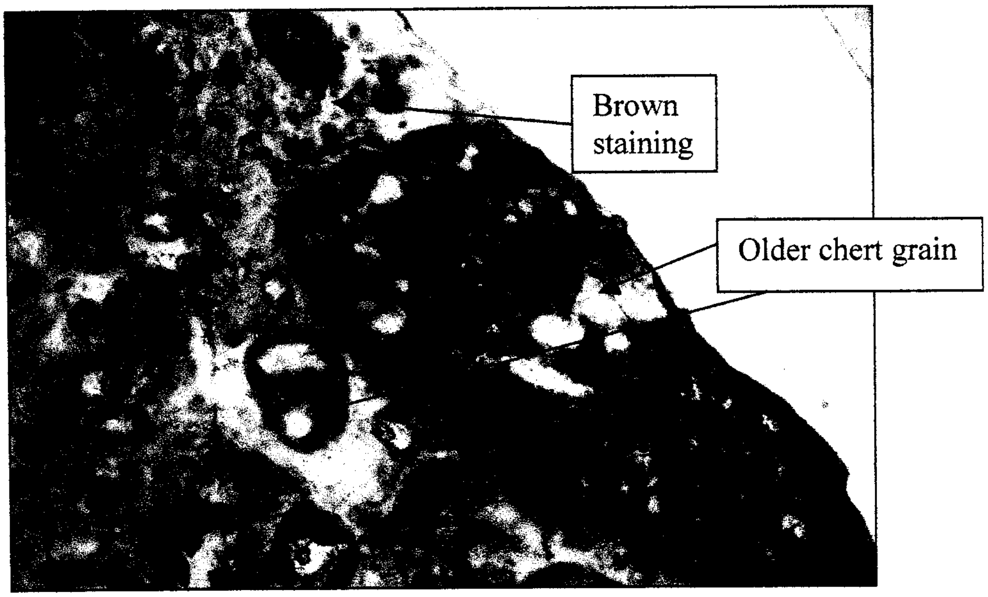

Figure 6.40: Raspadita1187.2.1 in plane polarized light under 2.5x magnification. Note: The width of field of view is 5 mm across.

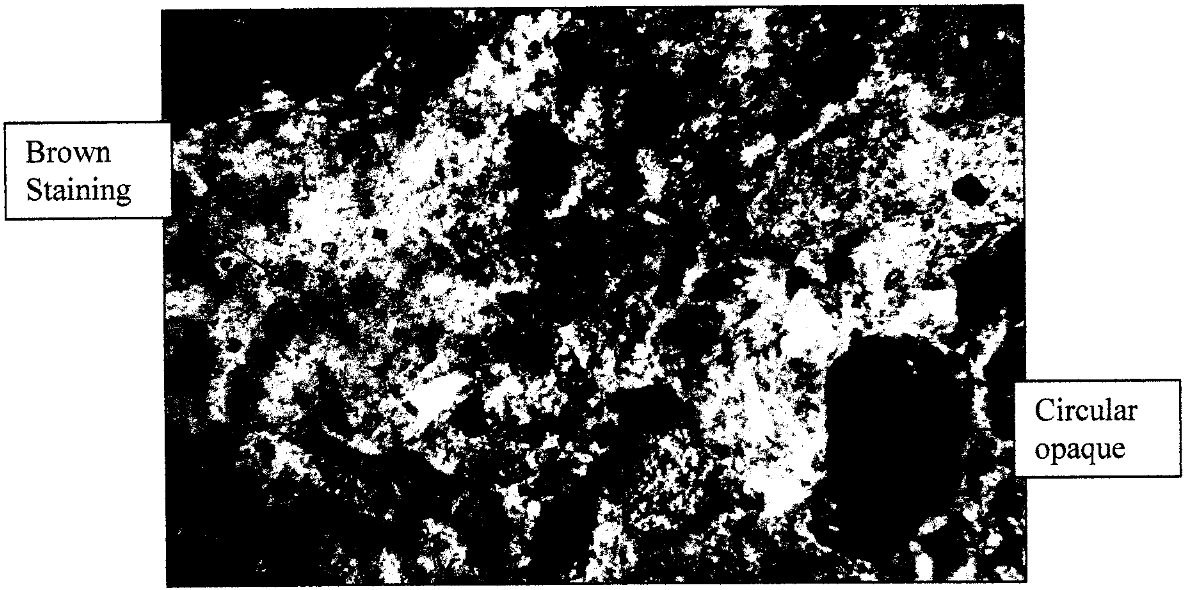

Figure 6.41: Raspadita 1636.25 in plane polarized light under 2.5x magnification. Note: The width of field of view is 5 mm across.

The drill (RI.44.03.1000.6) is made of very fine-to-fine grained quartz. It has no inclusions (Figure 6.42).

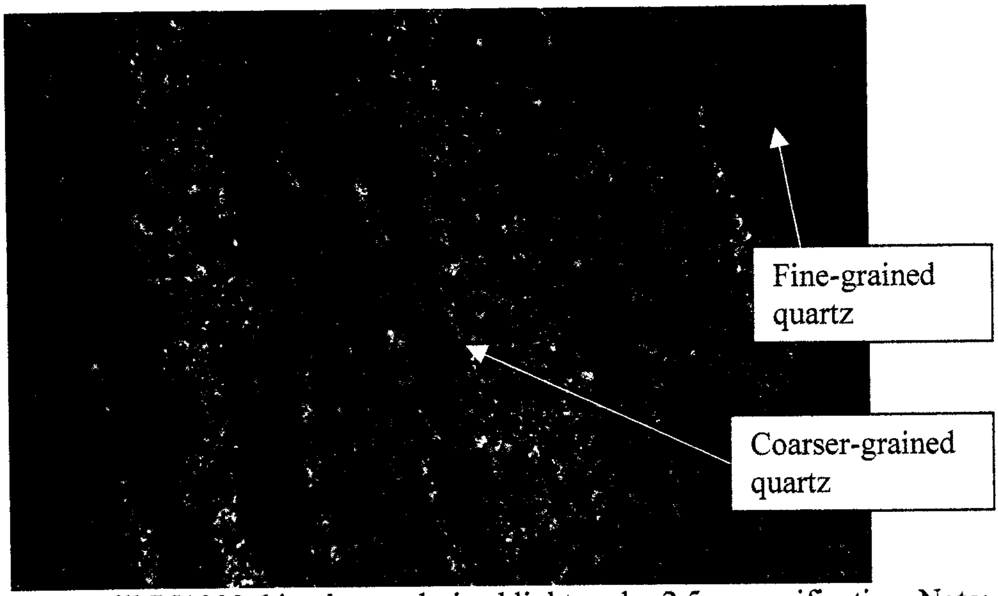

Figure 6.42: Drill RI1000.6 in plane polarized light under 2.5x magnification. Note: The width of field of view is 5 mm across.

All geological chert samples that were examined microscopically were from the collection site (JD.09.04) just south of Bocana El Coyol, Nicaragua. These samples were selected for their macroscopic similarities to the raspadita chert.

One sample (09.1) of white chert, without macroscopically visible inclusions (Figure 6.43), consisted of fine to very fine-grained quartz and altered plagioclase (<. 5mm to ~2mm) (Figure 6.44). There was also evidence of quartz overgrowths around plagioclase.

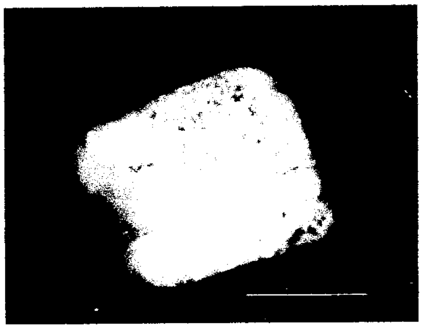

Figure 6.43: Chert Sample JD.09.04. Note scale bar is 1 cm.

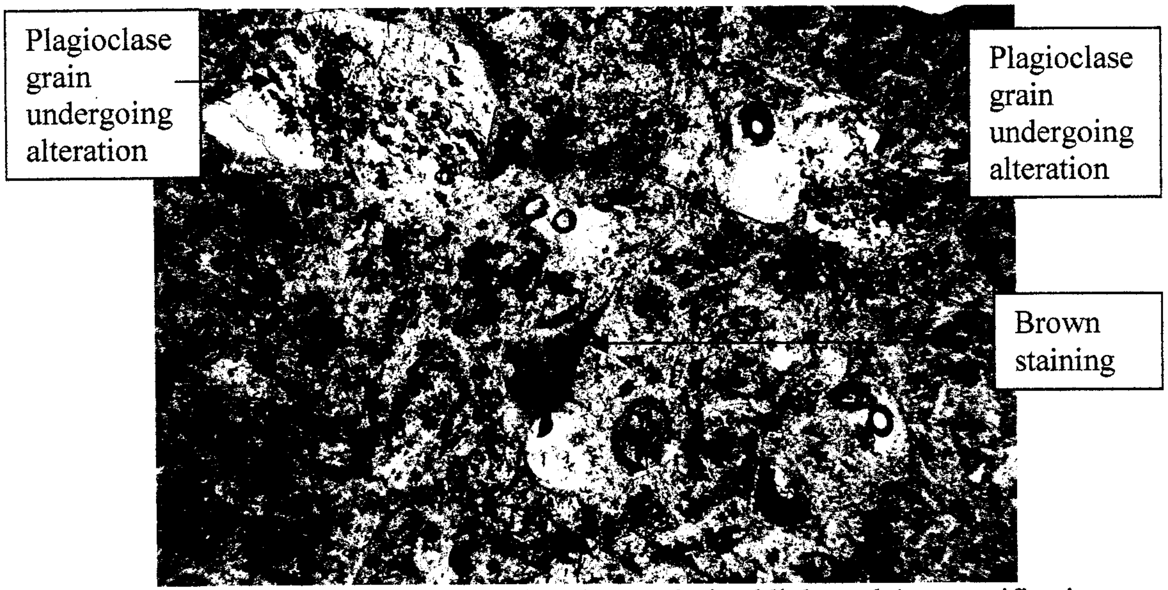

Figure 6.44: Chert Sample JD.09.04 under plane polarized light and 4x magnification. Note: The width of field of view is 2.5 mm across.

The other two other samples include a grey chert, with inclusions that had weathered pink and a pink/red chert with inclusions. They had similar mineralogies, containing voids, chert breccia inclusions, iron oxide staining, opaque minerals, large quartz crystals and amphibole grains (Figure 6.45, 6.46).

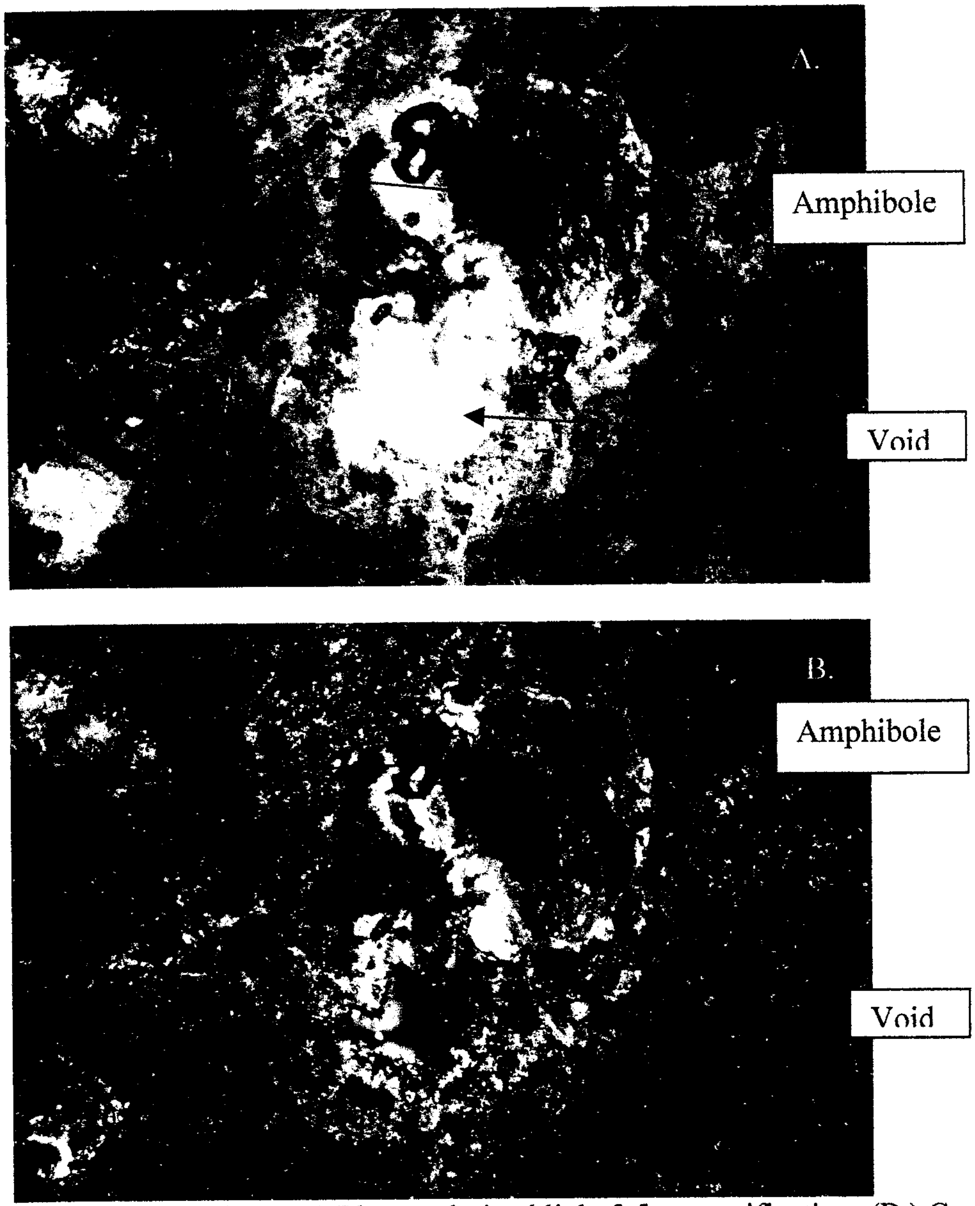

Figure 6.45: JD.09.04 sample 2 (A.) Plane polarized light 2.5x magnification. (B.) Cross polarized light 2.5x magnification. Note: The width of field of view is 5 mm across.

Figure 6.46: JD.09.04 sample 3, plane polarized light, 2.5x magnification. Note: The width of field of view is 5 mm across.

Chapter 7: Discussion

The results of the statistical analysis prove the first hypothesis that the raspaditas form a discrete class of artefacts. Other tool types were similar in some of their dimensions but, when all characteristics were compared in a cluster analysis, the raspadita tool classes could be differentiated. Two asymmetric raspaditas and several broken symmetric raspaditas had edge angles outside of the recognised range (60-120) for scrapers. This may indicate that a wider range of edge angles should be used for the classification of raspaditas than for scrapers.

The characteristics of the raspadita tool class are unifacial retouch, a length of 0.5 to 3.0 cm, width of 0.5 to 1.5 cm and a thickness of less than 1 cm. The proximal end is convex and has edge angles clustering from 70° to 110°, but ranging from 55° to 125°. The distal part is tapered with a blunt tip; the length of this tip ranges from about 1 cm to just under 0.5 cm and is less than 0.5 cm in diameter. The distal tip and proximal end are separated by the midsection (Figure 5.5), which slopes steeply towards the tip and contains some retouch, but minimal usewear.

The raspaditas were manufactured using unifacial retouch. The platform and flake characteristics indicate that a soft hammer fabricator was used to detach the raspadita blanks from the core. The size, shape and feather termination of the retouch flakes suggest that the retouch was accomplished using pressure flaking technology (Wilmsen 1968, Shepherd 1972, Grace 1989). The uniformity and minimal retouch implies effort was exerted to keep the raspadita's blanks similar in size and shape. The presence of blade and bladelet cores at Santa Isabel may indicate that the raspadita blanks were produced on these prepared cores. The fact that most raspaditas contain a single dorsal arris, and/ or two lateral ridges also supports this idea. If blade cores (>5 cm) were used, the blade could be snapped in half and two raspaditas produced. However, the majority of nodules recovered from Santa Isabel are quite small (<5 cm in diameter), making full blade production difficult. Bladelet (<5 cm) technology probably dominated.

The second hypothesis is that the raspaditas formed part of a composite tool. During the usewear analysis, similarities were found between the haft of the tanged point and the tips of the raspaditas. Both areas showed spot polish, rounding and striations in different localities from the microflaking. This type of microwear is often caused by the movement of a tool within a haft (Keeley 1982). Therefore, the tip of the raspadita and the haft of the tanged point were probably both hafted, resulting in similar wear patterns. As resin-like residues were not found on the tip, the raspaditas were probably held in place solely by mechanical forces. It is unlikely that a wrapped haft was used given the size of the raspaditas (Keely 1982).

The location of the raspaditas recovered during unit excavations in 2004 at Santa Isabel can be correlated with cultural deposits. The raspaditas were clustered together in groups within the cultural areas, supporting the idea that they were used as sets in a composite tool. Therefore, the usewear and spatial data support the hypothesis that the raspaditas formed part of a composite tool.

The majority of the usewear was found on the proximal end of both the symmetric and asymmetric raspaditas. This microwear included ventral ridge polish, dorsal ridge polish, dorsal edge microchipping, and ridge and edge rounding. Striations perpendicular to the edge were found on the ends of both symmetric and asymmetric raspadita. This configuration suggests that the ventral edge made contact with the material and the dorsal surface trailed behind in a unidirectional manner (Mansur 1982, Cook & Dumont 1983, Odell 2004). The lack of edge damage in addition to the microwear indicates that a soft to medium soft material was scraped. This could include meat, fresh hides, green plants, soft plants, non-fibrous plants; soft woods, dry hides, reeds, grasses, fibrous plants, and plants with silica (Odell & Odell-Vereecken 1981). The striations that run perpendicular to the ventral edge support this interpretation. Since striations show the direction of use, the raspaditas must have been used with their width perpendicular to the material similar to the fish scraper (Figure 1.4) (Brink 1978, Bradley & Clayton 1983, Bamforth 1987).

Some of the asymmetric raspaditas have striations that are parallel or transverse to the edge of their ends and midsections. Since all of the other microwear on the two types of raspaditas are identical, this indicates that the asymmetric ends made disproportionate contact with the material rather than having a different function. Of the tools examined, the end scraper was the only one to have similar usewear to the raspaditas, exhibiting polish, rounding, striations and microchipping. These similarities suggest that the end scraper and the raspaditas were used in a similar manner and support a scraping function for the raspaditas. The presence of the residues on the end supports the usewear finding that the convex proximal end was used for scraping.

The last four hypotheses relate to the material that was scraped: manioc, fish, maize, or a combination. The ovate residues discovered with SEM are similar in form and location to the experimental phytolith residues produced by Anderson (1980). Her work established a new relationship between phytoliths and the creation of polish. Previously, the silica in plants was thought to increase polish through abrasion. However, she demonstrated that phytoliths aid in the formation of amorphous silica. This liquefied silica is comprised of both the tool and plant silica and is responsible for the smooth surface of the polish. These experiments also found that during the formation of the polish, unmelted phytoliths can become trapped in the surface and in some cases retain enough of their structure to be identified (Piperno 1989, Piperno & Pearsall 1998).

The ovate residues adhering to the surface of the raspaditas were analysed using EDX spectroscopy on the SEM. As there were no additional elements present in the EDX spectrum and there was no drop in silicon count, the most likely composition of the residue is silica. Phytoliths, which are made of silica, can be characterized by their size, shape, ornamentation of walls, thickness of cell walls and orientation of cells (Piperno & Holst 1998). They range in size from 5 to 30 μm depending on the shape (Piperno 1989, Piperno & Holst 1998, Piperno & Pearsall 1998). The ovate residues are the right size, shape and material to be phytoliths. Their location in areas of high polish and only in use locales also supports this finding. An alternative explanation is that amorphous silica may have been liberated from its cryptocrystalline structure during use and formed these ovate masses (Morey 1962, Morey, 1964, Krauskopf 1979). The consistent dimensions and the structure of the ovate residues do not support this hypothesis of melting and recrystallization.

The extracted starch grains and phytolith residues indicate that the raspaditas came into contact with plants. As the raspaditas were recovered from agricultural fields, it is possible that these residues adhered to the surface after use. However, the restricted area and the tenacity of their attachment suggest that the raspaditas were used on plant material containing both starch and phytoliths.

The first type of composite tool type proposed as a function for the raspaditas was a manioc grater. Manioc graters have the width of the inserts parallel to the direction of motion, whereas, the usewear of the raspadita indicates usage was perpendicular to the width (Hawkes 1989, Piperno et al. 2000, Nieuwenhuis 2002, Perry 2003). Typical manioc grater inserts are unmodified flakes of obsidian (Roosevelt 1980, Perry 2003), whereas the raspaditas are elaborately knapped and made of chert. The residue analysis indicates that the plant processed by the raspaditas should contain both starch grains and phytoliths. The starchy tuber of the manioc plant contains no phytoliths (Bell et al. 1944, Nieuwenhuis 2002), although the plant does. However, it is unlikely that the plant stalks would have been processed.

There is considerable evidence against the manioc grating hypothesis, however, there is also some supporting data. The Nicarao are known to have eaten sweet manioc, which, although it does not require processing to be edible, could still be grated. Secondly, sweet manioc is presently grown and eaten at Santa Isabel by the descendents of the Nicarao (Figure 7.1). Although the tuber is not normally grated now, it is still possible that the raspaditas were used to grate sweet manioc in a non-traditional direction.

The thousands of fish bones found at Santa Isabel and the proximity of Lake Nicaragua support the second functional hypothesis that the raspaditas were fish scalers. The predicted scraper microwear for a fish scaler would be oriented perpendicular to the width (Tomenchuk 1997), as shown by raspaditas. No fish oil, blood or scales were found during the residue analysis, but a fish scaling function for the raspaditas cannot be eliminated by this lack of evidence.

Figure 7.1: Sweet manioc (*Manihot esculenta*) from Santa Isabel. Note: The manioc field was located between Locus 3 and 4 and was the reason that area was not excavated.

The raspaditas formed the majority of lithic tools found at Santa Isabel; as such their function should be of major importance. The Nicarao's diet focused on maize, beans and squash (Stone 1966, Tejada 1979, Fowler 1989). Therefore, maize processing is the third hypothesis proposed for the raspadita's function. The expected microwear for maize processing is scraping wear located perpendicular to width on the proximal end. This orientation is found on the raspaditas. The ovate residues found by SEM on the use surface of about half of the raspaditas are composed of silica, and are the right shape and size to be phytoliths. Maize, a phytolith containing plant, was an integral part of the Nicarao's diet. The functional usewear and residue analyses show support for the hypothesis that the raspaditas were used to process maize.

The final functional hypothesis was that of general processing with the composite tool used with the width of the proximal end orientated either parallel or perpendicular. However, the scraping microwear of the raspaditas shows only perpendicular use and the starch grains and phytoliths could be from different plant materials. Further residue analysis and identification would be needed to prove or disprove this hypothesis.

The raspaditas have been proved to be a coherent tool class with specific characteristics. The second hypothesis that the raspaditas formed part of a composite tool is also supported. Microwear analysis has shown the proximal convex end to be involved in a unidirectional scraping function with ventral edge leading and dorsal trailing, probably on a phytolith containing plant. The raspaditas were manufactured using soft hammer blade/ bladelet technology and pressure flaking retouch.

The general topography of Pacific Nicaragua and the climate means that there are few natural occurring outcrops of rock except in actively eroding environments, like the Pacific coast. The chert samples collected from Northern Costa Rica or southeastern Nicaragua are substantially different in macroscopic characteristics from the chert artefacts found at Santa Isabel. The Brito formation is the leading candidate for the source of the raspadita chert. This is the first report of chert deposits in Pacific Nicaragua (Fletcher et al. 1994).

As the Brito chert is found in turbidite flows, the chert nodules would have to predate the flow in order to be amalgamated into the deposit. Since the Brito formation is Palaeocene in age, the chert clasts must be older. The Rivas formation, that the Brito formation overlies, dates to Campanian-Maasrichatian period and the contact is a non-conformity implying a period of erosion or cessation of deposition. There are several steps involved in the formation of this chert conglomerate (Luedtke 1992). First the original chert will crystallize from silica-rich liquids in vugs in volcanics. Then the host rock is weathered and the chert nodules, washed downstream and deposited in the turbidites of the Brito Formation. The conglomerates are then raised above sea level and erode.

The only known natural outcrops of the Brito formation are along the southern Pacific coast of Nicaragua. Although the outcrops explored in the very brief field season did not yield the white chert with inclusions similar to the material of the raspaditas, it is possible that another outcrop would. The chert nodules that have been found are similar in superficial mineralology, the presence of inclusions and colours of other non-raspadita lithic tools. Further collection of nodules followed by optical and trace element analysis would be required to confirm the Brito Formation as the source for the Santa Isabel artefacts.

Pits were found on the majority of the raspaditas, and two of the non-raspaditas. These could be natural cavities in the chert formed during deposition of the chert and exposed during manufacture or use (Hayden & Kamminga 1977, Luedke 1992) or caused by heat-treatment (Purdy & Brooks 1971). A pink colour change, pot-lidding and increased lustre are commonly observed after chert has been heat-treated (Luedke 1992, Andrefsky 1998, Kooyman 2000). Some raspaditas have a pinkish vitreous lustre, indicating that they may have undergone heating. However, there is a considerable range of colour in chert artefacts at Santa Isabel (white-pink-red-purple-black). Therefore, it is also possible that this lustre and tint are natural variations. An additional possibility is that the chert might have been heated by igneous activity prior to the formation of the conglomerate (DeMets 2001, Marshall et al. 2003). If this was the case then heated chert could have been chosen for its improved knapping capabilities.

The cultural importance of the discovery of the raspaditas hinges on the fact that the inhabitants of Santa Isabel, the Nicarao, were a migrant group. However, there is no evidence for the raspaditas in the well-excavated area that the Nicarao are from. Instead, it appears that the raspaditas are a response to their new situation in Nicaragua.

When the Spanish arrived in Nicaragua they describe the foods consumed by the local people. These foods suggest that the Nicarao in Nicaragua were consuming the same types of food as their ancestors in Mexico (Fowler 1989). However, the presence of the raspaditas suggests that there was a change in their diet, possibly in the way in which a food was processed or prepared. Foodways theory states that a group has three responses to the stress of immigration: adopt the diet of the neighbouring people, blend the two diets or retain their traditional diet (Berry 1984). The appearance of the raspaditas at Santa Isabel supports a blending of the indigenous diet with that of the Nicarao.

The East coast of Nicaragua was inhabited by a group that had migrated from Columbia bringing with them traditional South American topical foods. One such food was bitter manioc. The Nicarao grew sweet manioc, which is similar to the bitter variety but does not contain the same level of cyanide and does not require the same processing. Bitter manioc is grated and sliced on large composite tools and then dried and pounded as part of a long process to release this poison, whereas sweet manioc is just boiled. It is possible that when the Nicarao arrived in Pacific Nicaragua these composite tools influenced them, resulting in the Nicarao modifying the traditional manioc grater inserts, which were unworked flakes, to fit an alternate use and their blade technology.

The chert nodules from the Brito formation are quite small with a limited amount of workable chert within the nodules (Figure 6.14B). This is different from the large pieces of obsidian traditionally available to the Nicarao through well-established trade networks around Cholula. The small size of the nodules may have played a part in the size of the blades available for reworking into tools. If the raspaditas were manufactured as bladelets they would be difficult to insert into a haft, as both ends are blunt. It would be possible to insert the bladelet with the long thin parallel side extended. However, a blunt end is needed since the raspaditas were used to scrape. In order to insert the bladelet end it would have to be reworked into a tip. It would then take little additional time to remove pressure flakes from the proximal end to create an ideal scraping surface.

Although, Santa Isabel is the only site known to contain raspaditas, it is unlikely that these tools were used at only one site. Therefore, it is important to determine the geographical extent to understand the transmission of the tool and the dietary alteration. The temporal range is equally important, as Santa Isabel is a single occupation site.

Chapter 8 Conclusions

The University of Calgary's recent excavations at the Nicaraguan archaeological site of Santa Isabel are the largest to take place in that region. The site of Santa Isabel extends beyond 16 hectares and contains no less than ten house mounds (Niemel 2000). Their use as domestic settlements was confirmed through excavation. Twelve radiocarbon dates place the single occupation between 800 and 1300 AD (McCafferty & Steinbrenner 2005). In addition, the low-lying areas between the house mounds have unearthed a number of human burials, dating to the same period (McCafferty & Steinbrenner 2005).

The lithic tools collected during this excavation were analyzed and a new tool type was discovered and named raspadita, meaning small scraper. The chert for the raspaditas may have been weathered out of the Brito Conglomerate on the Pacific Coast of Nicaragua. These tools are the vast majority of the lithic collection. As the raspaditas are new to the scientific literature, a detailed description of their characteristics is presented here. The function of the raspaditas was investigated with usewear and residue analysis.

The investigation showed a tightly defined lithic tool class. The raspaditas formed part of a composite tool used in a scraping motion, possibly on plant material. SEM and optical microscopy were the two major techniques, which contributed to these findings. Classic scraper usewear was discovered on the proximal end and hafting traces were located on the distal tip, supporting the composite configuration for the raspaditas (Cantwell 1979, Anderson 1980, Mansur 1982). Silica ovate residues, that are possibly phytoliths, were found by SEM to be imbedded in the ventral edge polish. A dumbbell shaped grass phytolith was extracted during residue analysis. Several unidentified starch grains were also extracted.

Four functional hypotheses were investigated using the configuration of the usewear. The evenly distributed ventral end edge polish, and dorsal end ridge polish and microchipping indicate a ventral leading, dorsal following scraping motion on a soft to medium soft material. This fits with the predicted pattern of wear of fish scalers, maize processors and general graters. Manioc grating, which usually requires the inserts to be width parallel to the direction of motion could not be completely eliminated, due to possible regional variation in grater board configuration. Additional residue and experimental usewear analyses must be undertaken to confirm the material the raspaditas were used to scrape.

It is possible that the raspaditas are not specific to Santa Isabel but have not been recognised as tools in other sites. However, they are probably absent from the well-analysed northern Nicarao sites. It is the less excavated areas surrounding Santa Isabel that could potentially yield undiscovered raspaditas. Therefore, the raspaditas at Santa Isabel and other southern Nicarao sites would present a unique opportunity to study ethnic dietary changes.

8.1 Future research

There are many possible directions of future raspadita study. One important avenue of research is the distribution of the raspaditas. Both the geographical and temporal extents are important facets of the raspadita story and necessary for future information about ethnic changes. The source of the chert for the raspaditas is not positively identified. This information is required for investigation of the strategy of raw material procurement. Heating experiments could determine if the chert was heated before use. Experimentation could confirm that the raspaditas were used in a scraping motion, on soft to medium soft plant material. Additional residue analyses could establish the material the raspaditas were used on, aiding in the determination of function.

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