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A

A QUANTITATIVE APPROACH TO ETHNOBOTANY:
THE SELECTION AND ASSESSMENT OF
A WOUND HEALING PLANT,
OHORU (*SYMPHONIA GLOBULIFERA* L.f),
USED BY THE WINIKINA WARAO
OF THE ORINOCO RIVER DELTA, VENEZUELA

by

ALFREDO GOMEZ-BELOZ

A dissertation submitted to the Graduate
Faculty in Biology in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy, The City
University of New York.

2001

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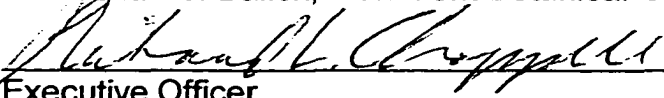
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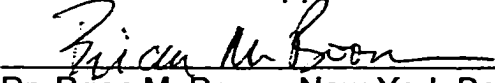
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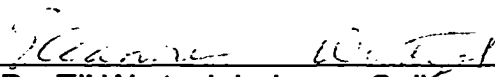
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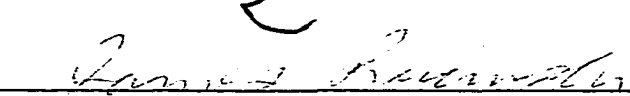

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Abstract

A QUANTITATIVE APPROACH TO ETHNOBOTANY:
THE SELECTION AND ASSESSMENT OF
A WOUND HEALING PLANT,
OHORU (*SYMPHONIA GLOBULIFERA* L.f.),
USED BY THE WINIKINA WARAO
OF THE ORINOCO RIVER DELTA, VENEZUELA

by

Alfredo Gomez-Beloz

Advisor: Michael J. Balick

The purpose of this dissertation research was to determine whether a plant's bioactivity, measured in a controlled setting, corroborates its ethnobotanical use. A questionnaire was used to measure plant use knowledge for 18 plants from 40 randomly selected Winikina Warao respondents of two villages in the Orinoco River Delta, Venezuela. Eleven (28%) respondents reported **ohoru** (*Symphonia globulifera* L.f.) as a treatment for wounds. **Ohoru** also had the highest Overall Use Value for wound healing and was selected for *in vivo* wound healing analysis.

The latex of **ohoru** was prepared and submitted to two *in vivo* linear incision wound healing bioassays to measure its wound healing activity by comparing breaking strength means of wounds treated with prepared 5% and 10% w/w **ohoru** extracts with control groups. Fresh **ohoru** extract was collected from the cortex of *Symphonia globulifera* trees in the Winikina region of the Orinoco River Delta. The single incision wound healing bioassay demonstrated that wounds treated with **ohoru** are healing at a normal rate. The double incision

wound healing bioassay results demonstrate that **ohoru** does not do better than the control group in affecting breaking strength.

Two types of efficacy emerge from this study: efficacy as reported by the Winikina Warao and efficacy as measured in the laboratory. The questionnaire results demonstrate that use of **ohoru** as a wound healing plant continues to be popular. Thus, efficacy of **ohoru** as a wound healing plant as reported by the Winikina Warao is corroborated. On the other hand, **ohoru** treatments used for the double incision wound healing bioassay did not do as well or better than the control group in the laboratory. Experimental error, sample group size, extract preparation, oxidation of **ohoru**, and use of dimethylsulfoxide as a solvent, may have contributed to the negative results of the double incision wound healing bioassay. This does not mean that **ohoru** is not an effective wound healing plant. Within its cultural context, **ohoru** is used to treat non-venomous laceration wounds and remains popular. Further studies in the laboratory are needed to quantitatively measure its wound healing bioactivity.

To my wife, Selina,
and my son, Joaquín.

Acknowledgements

This project was only possible with the support and collaboration of many people. I must first and foremost thank those without whom none of this would have been possible: the Warao of the Winikina River region of the Orinoco River Delta. Most significantly, I extend a strong embrace of love and thanks to my friend and partner, Tirzo Rivero, a village leader of Morichitos. I also extend the same to Lorenzo Moreno, headman of the village of España. Both gave me a glimpse of their home, a roof over my head, food to eat, and a taste of Warao culture. They assured their families, as I assured them, that no harm would come to anyone because of this project. They are the true heroes of life in the far reaches of the Orinoco River Delta. I hope that only good comes from this small morsel of Warao life.

There were many other Warao whom I met in the Delta who were helpful in carrying out this project. Most notably are Benigno Rodriguez, Basilio Arpintero, and Librado Moraleda. Benigno Rodriguez welcomed me to live in his home in Nabasanuka when I was on the river to Mojoina village. He also helped me translate to his language the questionnaire used for this dissertation project. Basilio Arpintero taught me much about my own role in Warao life at that space and time. We had many lively discussions on Warao culture and Delta politics. Librado Moraleda, village of Mojoina, welcomed me and gave me a dose of Warao life on the Aragua River. Indalecio Pizarro, Aristotere Pizarro, Juan Carlos Osorio, and Alberto Mocatera also gave me first-hand experience in preparing swiddens for planting *ure* (*Colocasia esculenta* (L.) Schott). I am

grateful to Geronimo, Daniel, and their sons, who built me a *wahibaka* (canoe) so I could get around in the Delta.

There were also non-Warao who live in the Orinoco Delta who have devoted part of their lives to helping the Warao and researchers, such as myself, learn more about their home in the Delta. I had the opportunity to meet these people at different times during the several expeditions I made to the Delta. Doctor Edgar Dominguez, epidemiologist for the Orinoco River Delta, provided me insight into Warao health status. He invited me to tag along on his visits to the many villages which dot the Delta. Padre Julio Lavandero, a resident of the Delta for over 25 years, supported my project and assured the Warao that I was only interested in their welfare. His voice of support meant a lot to me. He also provided me with transportation into and out of the study region. I also thank Monsignore Felipe González, Bishop-elect of the Delta, Sol Maria Mata, Elias Vasquez, Carmen Guzman, Carlos Queremel, Leonides Guzmán, and Nellys Guzmán. The nuns at Misión Araguaimujo also extended their generous hands by providing food to this sometimes starving ethnobotanist.

Drs. Werner Wilbert and H. Dieter Heinen were the two Warao specialists who opened the door for me in the Delta. Dr. Werner Wilbert introduced me to the Winikina Warao and took me on my first ethnobotanical expedition. I was able to discuss some of my points of view on Warao culture with Werner. His office was always open to me and we could talk for hours about life in the Delta. Dr. Heinen was another mentor to me on Warao life. I spoke with him both in his office and in the Delta. Both of these men have spent their

entire adult lives working with the Warao. They are two people who contributed to the success of this project.

In terms of shaping the ideas which led to this dissertation, I would like to express my deepest gratitude to my advisor, Dr. Michael J. Balick. He gave me my first opportunity to work with the Warao way back in 1991 when I was just getting my feet wet in ethnobotany. This opened the door for me to pursue a Ph.D. and make friends of an entirely different culture in another part of the world. He has stood by me through thick and thin and has always welcomed me.

I am grateful to Jan Stevenson for lending an ear whenever I had something on my mind. Even in 1991 when I was an Everett Intern at the Institute of Economic Botany at The New York Botanical Garden, she believed in me. She soon learned that I never gave up. I am grateful to Liz Pecchia who kept my line to Dr. Balick open. Sondra Lebest kept my line open with Dr. Boom. I am also grateful to Mee Young Choi for her friendship and enlightenment, as well as Daniel Atha. I am grateful to everyone else at the Institute of Economic Botany and The New York Botanical Garden for their assistance in many, many ways.

The didactic portion of this doctorate led to many friendships which I cherish to this day. Drs. Miguel Alexiades and David Williams took me under their wings and were the first to discuss ethnobotany with me in 1991. Camille Tipton and Andreana Ososki were the first classmates I had in the field of

ethnobotany. Both were not only good friends but professional colleagues as well. Camille was gracious enough to help me with *Hamelia patens* bioassays. Andreana read the questionnaire section of this dissertation and provided useful comments. Carlos Ramirez-Sosa's passion for botany and ecology was contagious. Our discussions on botany and ethnobotany led to his suggestion for the use of *Hamelia patens* for a study I was putting together on wound healing plants. Being a native of El Salvador, he was well aware of the use of *H. patens* for treating wounds. Amy Burkhoff and Betsy Hallihan were my lab mates when I was introduced to phytochemistry in 1996 by Dr. Barbara Meurer-Grimes at the Lehman College Phytochemistry Laboratory.

I am grateful to the faculty and staff at Lehman College, especially Drs. Gabriel Aisemberg, Dominick Basile, Thomas Jensen, Dwight Kincaid, and Yaakov Shechter.

I send a warm thanks to Dr. James C. Rucinski of the New York Methodist Hospital for sharing his medical knowledge with me and teaching me about wound healing bioassays. Jim is a top quality surgeon who always makes me feel at home with his humble demeanor and open mind. It was his openness that cued me into asking him to help me out with this project. He introduced me to wound healing and gave me practical instructions in carrying out live animal studies.

Dr. Brian M. Boom supported my interest in ethnobotany even in the early days when I was just getting into this field of study. He offered

guidance in carrying out fieldwork in Venezuela, a country about which he knows so much about.

Dr. Jack Valdovinos' serenity and compassion, as well as his interest in this dissertation project, were essential in my selecting him for my Advisory Committee. He is steadfast in his dedication to his students so I was fortunate to have him on my Committee. I am grateful to Dr. Eli Wurtzel who stepped in after Dr. Valdovinos' retirement. Her contribution was an important part to the successful completion of this dissertation.

A special thanks go to Janis Rozé whom I met in the early days of my work with the Winikina Warao. His own personal experience in fieldwork with the Warao made him a likely choice for my Final Examination Committee.

Together, my Advisory Committee and my Final Exam Committee contributed to the construction of this dissertation. However, any errors, omissions, or disputes which may arise from this dissertation, are strictly my responsibility.

Instituto Venezolano de Investigaciones Científicas (IVIC) was instrumental in the successful completion of my doctorate (see Appendix A). Doctor Egidio Romano, Director of IVIC, accepted and supported me as a student of IVIC. The *Instituto* provided me and my family with a place to live, a host of friends, and extended itself in helping me carry out this study while I was a Fulbright Scholar in Venezuela. Dr. Fabian Michelangeli of the *Laboratorio de Fisiología Gastrointestinal, Centro de Biofísica y Bioquímica (CBB)*, supported

this project from start to finish. Dr. Michelangeli welcomed my proposition to carry out this ethnobotanical project in Venezuela under his guidance when I first met him in his laboratory in 1997. I also thank the investigators of his lab for helping me feel at home. José Francisco Pérez, a friend and colleague, introduced me directly to Venezuelan culture. I also thank Giovanina Bella, Balentina Milano, Maria Gloria Dominguez Bello, Angel Fernandez, Maria Elena, Nelson, Maria Auxiliadora, and a number of other technicians who helped me in some way or other while I was at the CBB. A very special thanks goes to Carmen Quintana, legal counsel at IVIC, for advising and representing me in environmental matters in Venezuela.

Fundación La Salle was also instrumental in helping me carry out my field work (see Appendix B). They supported my project and made me a research associate at their institution. Nelson Herrera, Director of the *Instituto Caribe de Antropología y Sociología* (ICAS), and Bernarda Escalante, also of ICAS, extended a warm welcome and supported my project. Being a part of *Fundación La Salle* facilitated my entry into Warao country.

I would like to thank Ana Narvaez, Fred Stauffer, Lizbeth Stauffer, Giovanina Giardi, and Alexandria Jimenez of *Fundación Instituto Botánico de Venezuela* Dr. Tobias Lasser for welcoming me to the *Jardín Botánico*. They were always there to help in any way they could.

I owe a deep depth of gratitude to two friends who joined me in the Delta at different times and for various reasons: Dr. Wayne Shreffler and

Margarita Fernandez. Because of our experience of living and working together in the Delta, I learned much about being humble.

Several funding sources were essential for carrying out this research project. First and foremost, the MAGNET Program of the Office of Educational Opportunities and Diversity Programs of The Graduate School and University Center of the City University of New York (EODP-GSUC-CUNY), awarded me a four-year President's Fellowship to cover my tuition, as well as basic living expenses. Without this Fellowship I would never have been able to begin or complete my doctoral studies. Their commitment to helping talented minority students is essential for providing an opening into the environs of academia. Doctor Gail Smith, Acting Vice Provost and Director of the EODP-GSUC-CUNY, provided moral support during my tenure at the CUNY Graduate School. She was always around to make sure I never gave up despite the obstacles I faced to obtain the Ph.D.

An exploratory grant made by the Center for Environmental Research and Conservation of Columbia University in New York provided seed money for a preliminary study of the Winikina River Region of the Orinoco River Delta. Together with Dr. Charles M. Peters of the Institute of Economic Botany, The New York Botanical Garden, and my friend and neighbor, Dr. Wayne Shreffler, we came up with the idea for this grant. It provided enough money for two trips to the Delta. I am grateful to Dr. Peters for extending an interest in my graduate education and lending his professional expertise to support this project.

The J. William Fulbright Fellowship allowed me to live in Venezuela as a Fulbright Scholar with my wife and son during Academic Year 1998-99. This wonderful opportunity allowed us to absorb Venezuelan culture firsthand. I am indebted to Sharon Lerner of the Office of the Vice President for Student Affairs, GSUC-CUNY, for encouraging me to pursue the Fulbright Fellowship, and for being meticulous with me in filling out the application. Maria Eugenia Mendez, of the U.S. Embassy in Caracas, welcomed me to Venezuela, and was a liaison between myself and the U.S. Fulbright Office in Venezuela. She provided a much needed shoulder to lean on and together we shared our thoughts on Venezuela and life in general. Dr. Jeremy Carper, Cultural Attaché of the U.S. Embassy in Caracas, also provided much needed support to carry out my mission. He dedicated himself personally to the successful completion of this project while I was in Venezuela.

I must also thank the Garden Club of America who awarded me the Anne S. Chatham Fellowship in Medicinal Botany for 1999. This funded several of my expeditions to the swamps of the Winikina River of the Orinoco River Delta. Ms. Chatham's devotion to botany was directly responsible for the success of this project. Mr. and Mrs. Charles E. Schroeder provided the funds for the Chatham Fellowship in memory of Susan Willis Heiberger, a woman with a deep devotion to her family and her plants.

I am indebted to Joan Reid of The Ph.D. Program in Biology at The Graduate School and University Center of The City University of New York. Her detailed knowledge of CUNY bureaucracy and her personal wisdom always

came at the right time. Without her, I would not have been able to complete all the administrative details necessary for the Ph.D. I also thank Dr. Richard L. Chappell, Executive Officer of the same program, for supporting me as a student. Dr. Chappell understands the value of completing a Ph.D. and his caring compassion for his students shines through. He also supported my application for the Fulbright Fellowship. I would also like to thank Dr. Francis Degan Horowitz, President of the GSUC-CUNY, for being supportive of my dreams. I laud CUNY's mission to recruit and academically and financially support bright minority students with promising futures who would otherwise have little chance of entering academia. The diversity of life enriches humanity.

I would like to thank my family for their moral and financial support. My father, Augustine Beloz, and my mother, Margarita Beloz, though living almost 1,000 miles away, kept my spirits up by providing spiritual, as well as financial, support. They have witnessed my evolution from infant to adult, from husband to father, and now from student to Doctor. I would also like to thank my mother-in-law, Sylvia Aragon, for all her help throughout this project. Her encouragement and support of my family was essential for the success of this project. I also thank my father-in-law, Albert Gómez, and his family, for their spiritual and financial support. My uncle, Dr. George Beloz, and his family, were supportive also both spiritually and financially. My grandma, Carmen Beloz, was one of the main spiritual guiding forces for pursuing my dream of studying plants. She planted the seed of medicinal plant inquiry when, as a pre-teen adolescent, I would go with her on wild herb collection treks to Russell Square Park in the

Southeast Side of Chicago. She used them to prepare remedies for ailments which she shared with her family and community. She was a true *curandera*.

I dedicate this work to my wife, Selina, and my son, Joaquín. Together we conquered New York City, the Bronx, and Venezuela. They have stood by me throughout this doctoral study. I love them both dearly. They are my family and best friends. They are the most beautiful people I know.

Finally, I am grateful to all the Mexican Americans who have laid a path before me. Many have struggled, and even died, in the face of oppression and racism so that others, such as myself, could achieve a Ph.D. in the U.S.A. I hope this work serves as a testimony to what we, as Chicanos, can do when we believe in ourselves.

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Chapter 1.

Introduction

A. Introduction

My goal in pursuing this dissertation research was to establish a method to measure plant use knowledge and, using this data, select the plant reported most often as a treatment for non-venomous laceration wounds by the Winikina Warao. Then, I submit this plant, locally known as ***ohoru***¹ (*Symphonia globulifera* L.f.), to two *in vivo* linear incision wound healing bioassays to measure its wound healing activity by comparing breaking strength means of wounds treated with prepared ***ohoru*** extracts (5% and 10% w/w) with control groups. Using this data, I will determine whether the plant's bioactivity, measured in a controlled setting, corroborates its ethnobotanical use.

In this introductory chapter, I review several ethnobotanical approaches that could be used to describe the plants-people relationship. I explain why the ethnobotanical approach may be the preferred approach for identifying plants that may be important as future medicines. In Chapter 2, I describe the Orinoco River Delta study site and the Winikina Warao of yesterday and today. I discuss the preparation of the Winikina Warao swidden in Chapter 3. I also present a brief description of the Warao pneumatic theory of illness. This will set the stage for the questionnaire and bioassays.

¹ Names in bold and italics (e.g., ***ina***) are Warao terms. Names in italics are either in Spanish or are Latin binomials of plants and animals.

In Chapter 4, I discuss questionnaires as an ethnobotanical research tool. I describe the setting from which the questionnaire was developed. In Chapter 5, I describe how a cross-sectional questionnaire composed of a series of closed- and open-ended questions was designed and administered to 40 randomly selected Winikina Warao of two villages, Morichitos and España, located on the Winikina River. This section also illustrates in detail how the data was analyzed and how the Reported Use Value (RU), the Reported Use Value for a specific plant part ($RU_{[plant\ part]}$), Plant Part Value (PPV), Specific Reported Use, Specific Use Value (SU), Intraspecific Use Value (IUV) and the Overall Use Value (OUV), were developed to measure plant use knowledge for 18 plants commonly used by the Winikina Warao. Chapter 6 presents the results of the data collected from the questionnaires. The OUV is then calculated for plants reported as a treatment for wounds. The plant with highest OUV for wounds, **ohoru** (*Symphonia globulifera* L.f.), was selected. The specific goals of the questionnaire were to:

- measures plant use knowledge of 18 selected plants known to be used by the Winikina Warao;
- establish RU, $RU_{[plant\ part]}$, PPV, SU, IUV and OUV values for the 18 plants;
- identify the plants from the questionnaire reported for treating non-venomous laceration wounds and rank them according to OUV; and

- select the plant with highest wound healing OUV for *in vivo* linear incision wound healing analysis.

In Chapter 7, I introduce a brief discussion on wound healing and provide two examples of plants, *Aloe vera* L. and *Croton lechleri* Muell.-Arg., for which similar wound healing bioassays have been carried out. I describe how a preliminary wound healing bioassay, using the medicinal plant *Hamelia patens* Jacq., was used to establish a protocol for carrying out the linear incision wound healing bioassays. Using the basic protocol from this bioassay, two *in vivo* bioassays, the single incision and the double incision, were used to quantitatively measure the wound healing bioactivity of **ohoru** by comparing breaking strength means of treatment groups (5% and 10% w/w) with control groups in a laboratory setting. This is set forth in Chapter 9. The specific goals of the bioassays were:

- to establish a linear incision wound healing bioassay protocol using the medicinal plant *Hamelia patens* Jacq. prior to carrying out similar laboratory work in Venezuela;
- after selecting **ohoru** as the plant with highest Overall Use Value for wound healing as reported by the Winikina Warao, collect **ohoru**, the bark sap of *Symphonia globulifera* L.f., from trees in the Winikina region of the Orinoco River Delta;
- carry out the single and double linear incision wound healing bioassays, using 5% w/w (weight of extract/weight of solvent–w/w) and 10% w/w **ohoru** preparations for each bioassay;

- compare breaking strength means of treatment and control groups to determine if **ohoru** increases, decreases or does not affect wound breaking strength when compared to control groups.

Finally, in Chapter 10, I discuss the results of this research and how the information obtained from these results can benefit the Winikina Warao.

B. The Science of Ethnobotany

Ethnobotany is the branch of science that deals with plant-people relationships. The disciplines of anthropology (ethno-) and plant science (-botany) blend together to provide a qualitative and quantitative portrayal of plant use by humans. "Ethno-" refers to people or culture, which can be defined as "all the shared, learned knowledge that people in a society hold" (Loustaunau & Sobo, 1997, p. 10). "Cultural botany" is a fitting synonym for "ethnobotany" as cultural botany would relate to all the shared, learned plant use knowledge "that people in a society hold" (Loustaunau & Sobo, 1997, p. 10).

The use of plants by people has been important since the dawn of human history. Elaborate phytopharmacopoeias were an important part of American, African, Asian, and European peoples. The term "ethnobotany" was first used in the late 19th Century by botanist John Harshberger who discussed ethnobotany in a lecture as "plants used by primitive and aboriginal people..." (Anonymous, 1895). Early ethnobotanical research was carried out either by botanists or anthropologists who provided lists of useful plants usually used by indigenous people as a part of an ethnography (anthropologists) or as part of a

taxonomic treatment of those plants (botanists) (Balick, 1991; Bernardi, 1980). This collection of plants and describing their uses was the “classical” approach to ethnobotany.

Ethnobotany is distinct from economic botany in that the latter is based on the study of plants that have economic value and are utilized for the benefit of humankind while the former can be regarded as the study of useful plants prior to their exploitation and/or domestication (Wickens, 1990). These definitions are limited because although one may view crops produced in swidden plots as not useful to all of “humankind,” they are important to those people who use them. It has been suggested that this local forest intercropping system has allowed the tropical forests to remain intact even though they have been inhabited by humans for millennia (Posey, 1989).

Barrera (1979) describes ethnobotany as the study of traditional plant knowledge. In this case, “traditional” refers to the cultural value and significance of uses of plants over time. From another point of view, Martin (1995) states that ethnobotany is a branch of ethnoecology because ethnoecology encompasses “all studies which describe local people’s interactions with the natural environment.” This makes ethnobotany that branch of ethnoecology that deals with plants. Ford (1978, p. 46) states that “by recognizing phytogeography, plant ecology, and the population biology of each species defined as important by the human culture under study, an understanding of the processual interrelations between humans and plants...will finally be realized” (p. 46).

Despite all these different definitions of ethnobotany, it all boils down to ethnobotany being the study of people and their use of plants. An ethnobotanist can study the use of plants by the Yanomami of South American Amazonian Basin, plants used by people of the high mountains of Tibet, plants sold in the markets of Iquitos, Peru, or from the markets of Chinatown in lower Manhattan, New York. Ethnobotany not only focuses on plants of economic importance (food, medicine, construction) but on plants that may have non-material value, for example, to ward off spirits that cause disease.

The days of finding exotic cultures untouched by Western society are nearly gone. Material goods of Western origin can find themselves all over the world and in the most isolated places because they do make life easier in some cases. A plastic pail for carrying water is more durable and lasts a much longer time than a clay pot. A metal blade on a machete is much more efficient at cutting plants than a stone or wooden blade. Likewise, a metal axe blade can cut down a tree faster and easier than one made of stone. There are ecological, social, and psychological consequences, good and bad, for the introduction of many of these goods but change is inevitable.

Computers and the internet are bringing people closer than ever. Scientists and adventurers can now provide live coverage of their ventures into the farthest, most isolated, reaches of plant Earth. A recent National Geographic event tracked the flight of a balloon and its occupants as they attempted to fly around the world. Reports and pictures were sent live to a site on the internet for all the world to witness this event. In light of these recent developments—

change of culture and ease of communication around the world—it is imperative that ethnobotany continue to bring together the best suited approaches to more holistically understand the plants-people relationship for our continued existence on our home, planet Earth.

Richard Evans Schultes, an influential leader of ethnobotany, addressed the newly formed Society for Economic Botany in 1960 and stated that the ideal training for a student of ethnobotany should be “basically botanical with ample backgrounds in ethnology and ethnography on the one hand, and in plant chemistry and pharmacology or medicine on the other. A facility in learning languages would likewise be helpful” (Schultes, 1960). Although the implication here is that ethnobotanical exploration should focus on medicinally useful plants, this description nevertheless points to the multidisciplinary nature of ethnobotany. Today, ethnobotany involves not only making lists of plants but can embody ecology, economics, environmental policy, phytochemistry, pharmacology, public health, and other disciplines as needed to better understand the plant-people relationship (Balick, 1996).

The following are categories of ethnobotanical research approaches that have been reported in the last 35 years and continue to be used today to describe the plants-people relationship.

a. Ethnobotany of plants used by a group of people

Ethnobotanical studies which focus on the use of all the plants used by a group or several groups of indigenous people is the “classic” ethnobotanical

research approach to studying the plants-people relationship. The basic inventory of plants used by a group of people is essential for studying more complex plants-people relationships. This type of study stems directly from ethnographies where all aspects of a culture are studied, including plant use.

An example of this classical ethnobotanical approach is the work of Vickers and Plowman (1984) who describe the useful plants of the Siona and Secoya Indians of Eastern Ecuador. Ethnographic data, common names and uses for 224 species of plants known to be used for this indigenous group are described.

A study of the useful plants of the Waorani Indians of Eastern Ecuador (Davis & Yost, 1983) describes the historical context of medicinal plant use by the Waorani. They also provide an ethnographic description of the Waorani, and list plants for the following medicinal use categories: plants for fungal infections and/or scabies infestations, to treat Tropical Warble Fly infections, tooth decay, various stings (scorpion, spider, insect, stingray), and snake bites. Scientific name, common name, and uses are listed.

Aminuddin and Girach (1991) described the useful plants of the Bondo Tribe of the Koraput (Orissa) District in India. They provided a brief ethnographic account of the Bondo people and listed 44 plants used by this group. Common and scientific names, plant family, habit, locality, and folk uses were provided for these plants. Another ethnobotanical study from the south of India, Tamil Nadu, provided a list of 50 plants used by the Irula people of the

Kodiakkarai Reserve Forest. These plants are used for food, medicine, thatch, fuel, festivals, and rituals. Common and scientific names were provided (Ragupathy & Irulas, 1991).

Lentz (1993) describes the ethnobotany of the Paya of Honduras. He provides the location and climate of Paya territory, and gives a detailed ethnographic account of the Paya in terms of language, history, food procuring practices, political and social arenas, home gardens, crops and medical practices. He also lists the useful plants of the Paya and provides scientific name, common name, ecological information and uses.

An inventory of useful plants provides a basic framework from which a wider range of studies can be made. The basic plant inventory also allows for the proper identification of plants for the scientific community. Thus, ascribing scientific names to folk/common names is a more verifiable source of information (Daly, 1993-94). From this inventory, specific questions can be answered about the plants-people relationship.

b. Ethnobotany of one plant species

Another approach to studying ethnobotany is to describe the many ethnobotanical uses of a plant species by one or several groups of people. For example, Morgan (1980) takes a look at sweetflag (*Acorus calamus* L.) use among North American Indians. He provided a taxonomic description, distribution of the species and the common names and uses of sweetflag by North American Indians.

A study of the *cohune* palm, *Orbignya cohune* (Mart.) Dahlgren apud Standl., was carried out in Belize by McSweeney (1995) who described the uses of this palm, especially its use as a flybrush, for thatch oil, and for palm heart. The ethnobotany of *chamairo* (*Mussatia hyacinthina* (Standl.) Sandw.), a liana whose bark is used as an admixture to sweeten a coca quid, was described by Davis (1983). He discussed the varieties of *chamairo*, especially white, red, and yellow, and how they are used by coca chewers in Bolivia and Peru. He also provided the medicinal properties of this species (Davis, 1983).

A report on the ethnobotanical uses of the orange (*Citrus aurantium* L.) has been reported by Paul and Cox (1995) for Haiti. Patiño (1992) discussed the palm *Bactris gasipaes* HBK and its geographic distribution, common names, reasons for cultural importance of the palm, harvest and fertility festivities surrounding the palm, myths, beliefs, post-Colombian folklore, its practical uses, and harvesting methods.

The palm, *Astrocaryum chamhira* Burret, has been studied for its ethnobotanical uses as reported by the indigenous people of Amazonian Ecuador (Jensen and Balslev, 1995). The taxonomy of the palm and its genus, harvesting, and products made from the spear leaves, marketing and economic importance of the products, and economic potential for the palm products are described. In another example, the ethnobotany of *Cissus quadrangularis* (Vitaceae) from India is provided by Kumbhojkar, Kukarni & Upadhye (1991). A literature review, taxonomic description and uses (medicinal, edible, ornamental, and other) are provided.

An interesting set of ethnobotanical uses for *Prosopis cineraria* Druce (Mimosaceae) has been described by Hosagoudar and Henry (1991). These uses are described for the people of Bilgi in the Bijapur District of Karnataka, India, for whom *P. cineraria* is a sacred tree. Among its uses are to keep away evil spirits; a bowl of milk is boiled in the shadow of the tree and the direction the milk spills over from the bowl points to where good fodder trees are available; barren women worship the tree for three months to beget children—if the woman conceives, the tree dries up; because it is believed to be an indicator of ground water sources, wells are usually built near this tree. *P. cineraria* is also used as a long straight pole to which cattle are tied to thresh wheat, and a straight rod made from the stem is used for churning milk to butter.

Oftentimes a specific plant or group of plants is of importance to one group or several groups of people. Thus, ethnobotany of one plant species, genus, or family, can provide valuable insight into the variety of uses of a specific plant by several groups of people. This plant may have a wide range of uses depending on the cultural context of the people who use that plant. Thus, a plant species may have different uses across a number of cultures. This method provides a wholistic look at a specific plant species, genus, or family.

c. Ethnobotany of a group of related plants (genus or family)

Another approach to ethnobotanical research is to study an entire group of related plants (genus or family) for their ethnobotanical importance. Balick (1984) describes the ethnobotany of palms (Arecaceae) in the Neotropics. The history of palms and taxonomic treatments are addressed, as well as the

nature and diversity of palm use, for seven ethnobotanically important palm genera known throughout the Neotropics: *Bactris* Jacq., *Euterpe* Mart, *Jessenia* F. Muell ex Sond., *Lepidocaryum* Mart., *Mauritia* L.f., *Maximiliana* Mart., and *Orbignya* Mart. ex Standl. In another example, the genus *Viola* (Myristicaceae) has been studied because many of its species are culturally important as hallucinogens (Schultes, 1969).

An example of a detailed study, or monograph, of an important plant species is that of the ethnobotany of coca (*Erythroxylum* spp.) by Plowman (1984). A detailed taxonomic description of two ethnobotanically important and closely related South American species of *Erythroxylum*, *Erythroxylum coca* Lam. and *E. novogranatense* (Morris) Hieron., was presented. Plowman also discussed the discovery and cultivation of coca, archaeological evidence for coca chewing, coca cultivation, preparation of leaves for chewing, mechanics of coca chewing, coca chemistry, admixtures for the coca quid, and the effects of coca chewing. Plowman included use of coca as a medicine and stimulant, and its role in religious and social life in Colombia, Peru, Brazil and Bolivia, countries from where these two *Erythroxylum* species are found.

The historic and present day uses of bamboo (Poaceae) in Jamaica has been described by Rashford (1995). Although bamboo was used in the past primarily as a fiber, today it has domestic and agricultural importance as well. Bamboo is used for making long poles, musical instruments, household articles, containers, rafts for transport and sport, crafts to sell to tourists, as a fuel, for folk

medicine, in landscaping, erosion control, diet, fishing, and some bamboo species have a connection to the spiritual world.

Verma, Vishwadhar, Ngacham, et al. (1991) describe the edible fungi of Northeastern India, especially in the regions of Meghalaya and Maryum. A total of 18 fungi are described for which morphologic and diagnostic characters, scientific and common names, places of occurrence and the marketability of some species is provided.

A review article on the use of the family Cucurbitaceae by Yang and Walters (1992) stated that the Cucurbitaceae of China include 157 species of which 63 (40%) have some use, especially as a fruit, vegetable, or medicinal herb. The most used species cultivated by China for export to the world include “squash (*Cucurbita* spp.), cucumber (*Cucumis sativus* L.), cantaloupe and other melons (*Cucumis melo* L.), and watermelons (*Citrullus lanatus* (Thunb.) Matsumura & Nakai).” Another review article by Jain (1995) reported on the ethnobotanical uses of the Zingiberaceae by tribal and other ethnic groups in India. Of the 170 Zingiberaceae species found in India, 31 species have some ethnobotanical use. The eight genera to which these species belong are *Alpinia* (Schum.) Smith, *Amomum* (Schum.) Tsai & Chen, *Curcuma* Tong, *Globba* Larsen, *Hedychium* Roxb., *Kaempferia* Ridley, *Roscoea* Smith, and *Zingiber* Boehm. Most uses are for food and medicinal purposes.

A genus or family of plants may have a wide variety of uses (e.g., *Palmae*) or may be used by a number of groups of people for one use (e.g.,

Erythroxylum). These studies demonstrate that a genus or even an entire family of plants may be important for people based on their morphological and physiological characters.

d. Ethnobotany of a specific plant use

A description of a specific use for a plant genus or family is also found in ethnobotanical studies. Plotkin and Balick (1984) reported on the medicinal uses of 48 palms reported by several indigenous groups of South America. The authors give genus and species names, common names, specific medicinal uses, geographic region from where they are reported, and the indigenous groups that employ that use. In another study, Wasson (1961) presented a detailed description of the rituals involving hallucinogenic fungi use in México. A list is provided of the fungi known from México up to 1960 and gives scientific name and first reported use. Not all of the mushrooms reported are hallucinogenic—some are said to have religious significance based on their shape.

Palms and their use in religions of the Northwestern Amazonian people is described by Schultes (1974). He discussed the uses of several palms and their role in the religious beliefs, symbolism, and magic rites as practiced by these people. *Astrocaryum vulgare* Mart., *Bactris gasipaes* HBK, *Bactris* sp. Jacq., *Euterpe oleracea* Mart, *Jessenia bataua* Murret, *Leopoldina piassaba* Wallace ex Archer, *Lepidocaryum tenue* Mart., *Mauritia flexuosa* L.f., *Mauritiella cataractarum* Dugand, *Maximiliana martiana* Karst., *Oenocarpus bacaba* Mart., *Parascheelea ancbistmpetala* Dugand, and *Socratea exorrhiza* Wendl. are the

palms for which a religious use is attributed by the indigenous people of this region. Sensarma (1991) and Jha, Choudhary & Saraswati (1991) describe plants used as veterinary medicines for horses, elephants, and cows, in India.

Some ethnobotanical studies focus on a specific product made from plants. For example, a study by Hettinger and Cox (1997) provided an ethnobotanical description of the construction of the ***Kato Alu***, a traditional basket made on the islands of Vav'u and Tongatapu, Tonga. They describe the material used to construct the basket, oral traditions and legends surrounding the basket, and described the steps for manufacturing the Tongan basket. A study by Gomez-Beloz (1997) described a spinning top made from the ***yaha*** palm (*Manicaria saccifera* Gaertn.) by the Winikina Warao Indians of the Orinoco River Delta.

This method of describing an important plant use is similar to the previous categories except that these studies focus on a specific use for one plant or a group of related plants (genus, family). These type of studies target a specific use of interest to the people who use the plant and scientists who study the plants.

e. Ethnobotany of plants grouped by morphologic characters

Ethnobotanical studies can also focus on plants with specific morphologic characters that make them useful as a group even though they may not be directly related by family or genus. For example, lianas (vines) have a wide variety of uses. Paz y Miño C., Balsler, & Valenci (1995) described the

uses of a variety of lianas used by the Siona and Secoya Indians from Amazonian Ecuador. Another example is provided by Basualdo, Zardini, & Ortiz (1995) who investigated the medicinal properties of underground plants organs (hypocotyl-root axis, adventitious roots, roots, rhizomes and xylopodia) of Paraguay. The use of ferns in Gonwhal Himalaya, India, was presented by Gaur and Bhatt (1994), who provided common names, uses, and taxonomic treatments of the reported ferns.

f. Quantitative ethnobotany

The science of ethnobotany may also include ecological information that could be used to strengthen the argument for the plants-people relationship and its importance for tropical forest conservation. More than just listing the names and uses of plants used by a group of people, ecological information is collected to understand the plant-people trends in relation to culture and economic activities over time (Balick & Cox, 1996, p. 179-208; Bye 1995, p. 424). Although not popularly used in ethnobotanical studies, surveys/questionnaires can also be used to provide information about plant uses by a group of people. The role of questionnaires in collecting ethnobotanical information will be discussed in Chapter 3.

A watershed in the quantitative approach to ethnobotany was the study of the Chácobo Indians of Bolivia by Boom (1987). Boom used two approaches for obtaining ethnobotanical information. First, he used the “artifact/interview” approach which involved identifying artifacts, asking about material used to make the artifact, and going to the forest to collect a voucher

specimen. This had been the usual approach to obtaining plant use information. He then used the "inventory/interview" technique, the reverse of "artifact/interview," which involved collecting plants from the nearby forest, bringing them to the informants, and asking what, if any, use or uses is attributed to the plant. He also established a one hectare plot and marked all trees over 10 cm DBH. He then walked with Chácobo natives through the plot and asked about the uses of the marked plants. Three hundred sixty (360) plants were reported to be used. Scientific and common names were provided and all reported uses by the Chácobo were described. Boom established use categories which included food plants, fuel plants, construction and craft plants, medicinal plants, and poisonous plants. He was also able to quantify the number of species used by the Chácobo from the study forest plot, as well as rank the plants in order of use importance.

Boom found that in the one hectare plot, 82% of the tree species were utilized, emphasizing the importance of the forest for the Chácobo. Using this data, he was able to quantitatively demonstrate the need for conservation of the forest. By deriving a use value for the plants, he was able to show that the forest species are widely used by the Chácobo and should be protected because of their value to the Chácobo. Equally as important, this study demonstrated that although the forest is widely used by the Chácobo, there is little to no injury to the forest. Boom (1990) carried out a similar study with the Panare Indians of Venezuela. That time he conducted two forest inventories because of the two unique vegetation types utilized by the Panare: mountain forest and tall woody

savanna. He was again able to demonstrate the importance of the forest to the Panare people.

Prance, Baleé, Boom & Carneiro (1987, 1995) set up a large scale quantitative study by establishing four one-hectare plots in four parts of the South American tropics used by four indigenous cultures: Ka'apor (Brazil), Tembé (Brazil), Chácobo (Bolivia) and Panare (Venezuela). A total of 99 plant species were collected from the Ka'apor plot of which 76 (76.8%) were utilized. Of the 119 species collected from the Tembé plot, 73 (61.3%) were utilized. The Chácobo plot had 94 species of which 74 (78.7%) were utilized and the Panare plot had 70 species of which 34 (48.6%) were useful. Plant uses were divided up into food, construction, material, technology, remedy, commerce, and other use categories. The authors concluded that because of the high number of tropical forest plant species used by these indigenous groups, the forest is important for the survival of those who live there. They demonstrated the importance of specific species to each indigenous group and the importance of families of plants for these four groups. Finally, the authors used their data to support the argument that there is an important need for creating nature reserves throughout the earth's tropical forests.

Another quantitative ethnobotanical study was carried out by Grimes, Loomis, Jahnige, et al. (1994) who set out to compare the economic value of traditional forest plots with the value of a hypothetical tree farm planted in the same area. They collected qualitative and quantitative data to establish the value of non-timber forest products extracted from three permanent one-

hectare plots in the Upper Napo region of Amazonian Ecuador. The native inhabitants of this region, the Quijos, were consulted to provide ethnobotanical and ecological information about the uses of lianas and trees in these plots. Ecological data that was collected included fruit yields, bark production, and resin production from the trees. By estimating maximum production levels, including the cost of getting the non-timber forest products to market, an estimated market value for several plant species was calculated. The investigators then estimated the amount of timber which could be grown in the same plots if they were converted to timber production. They found that the net value of the present forest system was higher than if it was converted to a timber farm. Although local factors such as "floristic composition, site quality, disturbance history, local policy, and distance to markets" affect value of the forest, the authors argue that creating incentives to attract local users to conserve and sustain these forest systems, instead of converting them to timber farms, is needed to help in the conservation of tropical forests throughout the world.

In further pursuit of quantifying the value of the forests to assess its economic potential and, in turn, advocate for tropical forest conservation, Mendelsohn and Balick (1995, 1997) provided data on the value of undiscovered pharmaceuticals from the tropical forest. They estimated that the number of drugs which remain to be discovered is based on a number of variables which include 1) number of flowering plant species in tropical forests, 2) plant part used, 3) extraction procedures, 4) number of screens to be used, and 5) success rate of obtaining a viable drug. Using these variables, they estimated that 328 drugs

remain to be discovered from the world's tropical forests. The estimated value of one drug discovered from one plant in a tropical forest may have a net value of \$109 billion (based on the difference in drug development costs and expected sales revenues). Using these calculations and estimates, Mendelsohn and Balick (1995, 1997) presented the following rationale for conserving tropical forests: the higher the abundance of tropical forest ecosystems in a country, or region, the greater chance for discovering a new drug from the tropical forests of the world, thereby offering long-term economic incentives for those who conserve tropical forests.

As shown above, ethnobotanical and ecological data can be used together to support the argument that the economic and cultural value of tropical forests inhabited and used by people throughout the world is greater than simply cutting down the forests for pasture or large-scale agricultural production. Eco-ethnobotanical studies have demonstrated that swiddens, swiddens in fallow, and surrounding forest are anything but unmanaged (Posey, 1989; Paitán, 1988; Salick & Lundberg, 1990). Thus, quantitative assessment of forests based on a combination of ethnobotanical and ecological data are strong advocates for tropical forest conservation (see Bernstein, Ellen, & Antaran, 1997; Campbell, Daly, Prance, et al., 1986).

In summary, the six types of ethnobotanical methodologies mentioned above are 1) ethnobotany of plants used by a group of people, 2) ethnobotany of one plant species, 3) ethnobotany of a group of related plants (genus or family), 4) ethnobotany of a specific plant use, 5) ethnobotany of plants

grouped by morphological characters, and 6) quantitative ethnobotany. Each category has its exceptions and there is always room for including other categories.

My dissertation will focus on quantitative ethnobotany. I will use quantitative data to measure the efficacy of a specific use for a plant. The two principal tools I will use include a questionnaire and bioassays. I will survey a population to collect ethnobotanical information from 40 randomly selected participants of two villages, Morichitos and España, located on the Winikina River in the Orinoco River Delta, Venezuela. From this data, I will select a plant with highest specific ethnobotanical use as a medicine and conduct *in vivo* bioassays to corroborate that ethnobotanical use.

C. Identifying Plants With Ethnobotanical Importance

The purpose of the research for this doctoral dissertation was not to “discover” new medicinal plants used by the Winikina Warao. However, because this is an ethnobotanical study which targets a specific use from within a select group of plants, it is important to discuss the two basic approaches used to identify plants with bioactivity: the random approach and the targeted approach (Balick, 1990; Balick & Cox, 1996, p. 37-40).

a. The random approach

The random approach to collecting plants for pharmacological investigation involves collecting plants “from a given region and [screening them] without regard to their taxonomic affinities, ethnobotanical context, or other

intrinsic qualities" (Balick & Cox, 1996, p. 37). This approach of collecting all plants and putting them through a general screening process to test for bioactivity has been used by the National Cancer Institute, Merck and other pharmaceutical companies (Artuso, 1997; Mays, Duffy-Mazan, Cragg, et al., 1997; Albers-Schönberg, 1996; Caporale, 1996). For the most part, this research has targeted compounds that are active against diseases for which a market for the compound exists and would make the new drug profitable for the pharmaceutical company which develops it (Borris, 1996).

Although the random approach may not be as effective as the targeted ethnobotanical approach in identifying a bioactive compound, it is becoming the preferred method in screenings used by pharmaceutical companies (Borris, 1996). With the advent of efficient bioassays that can test bioactivity at the molecular level, the random approach method is preferred because it allows testing of hundreds of plants in a variety of extract concentrations in a short period of time. Also, the advent of combinatorial chemistry has made searching for novel compounds with specific activity a task of identifying a basic compound structure and manipulating it into a myriad of combinations using computer software to determine whether it is suitable for specific bioactivity. However, as Huxtable (1992) states, "although chemists can ring many changes on a known structure, for the foreseeable future we will still rely on Nature to supply us with new structural types for investigation." Combinatorial chemistry can manipulate a compound structure but only Nature can provide unique structures. Because many receptors of medical interest for

which a pharmacological product may be useful are still unknown, “as long as the chemical structure of receptors is unknown, Nature will remain the major reservoir of molecules which can be used to cure disease” (Sévenet, 1991).

b. The targeted approach.

The targeted approach uses intrinsic plant properties such as phylogenetic, ecological, ethnozoological, or ethnobotanical information to target specific plants or groups of plants that may have interesting bioactivity (Cox & Balick, 1994, Balick & Cox, 1996, p. 37-40; Cox, 1994; Rodriguez & Wrangham, 1993). These categories are not always all inclusive as ethnobotanical and ethnozoological information can be combined with phylogenetic information to find plants of interest as protomedicines. The phylogenetic approach involves targeting plants that are evolutionarily related or are known to produce useful compounds unique to a specific plant genus or family. For example, betalains are secondary metabolites strongly represented in the Order Caryophyllales (Cronquist, 1988, p. 312). Species, genera, or families in that Order may be analyzed for betalain or betalain-related compounds.

The genus *Virola* (Myristicaceae) has a strong potential for compounds that may be effective in treating dermatological problems as many *Virola* species are used to treat dermatological problems (Plotkin & Schultes, 1990). Also, phylogenetic relatives may be of interest because compounds with similar bioactivity in selected plants may be found in other *Virola* species that are less toxic, less costly to extract, and/or easier to isolate. In this case, phylogenetic and ethnobotanical approaches are combined.

In the ecological approach, plants that exert ecological influences may be chosen for study. For example, ecological characteristics can include compounds produced and released by a plant growing in an environment that requires it to be more resistant to pathogens. A plant's immunity to specific pathogens makes its metabolites of interest as insecticides. Plants that exhibit allelopathy, "the inhibition of one species of plants by chemical produced by another plant" (Raven, Evert, & Eichhorn, 1992, p. 738), are also of interest. For example, the Black Walnut tree (*Juglans nigra*) exerts chemical herbicidal influence on other plants that grow around and under these trees. Alfalfa and tomatoes die when they come near or in contact with Black Walnut. Another example is sorghum which is planted with agriculture products to reduce the growth of weeds because it releases allelo-chemicals into the soil. Compounds from Black Walnut and sorghum may be of interest for their herbicidal properties (ibid., p. 738).

Ethnozoology is the study of animals and the plants they use for treating their ailments. Cases of plant-animal interactions have been reported primarily for primates, including chimpanzees, howling monkeys, marmosets, black and white colobus monkeys, and baboons (Glander, 1994). Rodriguez, et al. (1984) observed chimpanzees eating large amounts of *Aspilia* sp. (Asteraceae) in the morning. Based on these observations, they thought the plant might have antimicrobial activity. Through phytochemical analysis, they found that the plant was high in a thiophene, *Thiarubrine A*, which was confirmed, through laboratory analysis, to have antimicrobial activity (McLachlan, Arnason, & Lam, 1984).

Thiophenes are polyacetylene compounds with a ring structure that incorporate sulfur and are well known light-activated phototoxins (Marles, Arnason, Compadre, et al., 1991). They are most commonly found in the Asteraceae, the largest of the angiosperm families (Cronquist, 1988, p. 446). The first thiophenes were isolated from marigold (*Tagetes* spp.) petals and *Coreopsis* spp (Ettlinger & Kjaer, 1968). Several plant species in the Asteraceae could now be tested for thiophenes and antimicrobial activity. Thus, ethnozoological and phylogenetic approaches were combined in this case.

The ethnobotanical approach focuses on plants used by people and choosing those that are used for a specific illness and analyzing them for further study. Any of the six methodological approaches described earlier in this Chapter can be used to collect ethnobotanical information from plants. The ethnobotanical approach involves two components: the pre-screen filter and the ethnobotanical filter (Balick, 1990). The pre-screen filter is the trial-and-error method of trying new plants over a period of several hundred to thousands of years. Those that are active for physiological or supernatural reasons become established and widely used in the pharmacopoeia. As Etkin (1988) points out, plants are not randomly chosen. There is a method of choosing plants that are efficacious in the cultural context within from which they are used to treat disease.

The second component involves the ethnobotanical filter whereby plants that are used by a group of people for treating illness are selected by the ethnobotanist for further analysis. Balick (1990) found that when testing for anti-

HIV activity in plants selected randomly and plants selected by their ethnobotanical importance, those that had an ethnobotanical association showed greater bioactivity in the anti-HIV *in vitro* pharmacological bioassay screen used by the National Cancer Institute (NCI). Later, dereplication of these extracts, removal of “unimportant” plant products such as tannins and polysaccharides, by NCI staff caused a drop in anti-HIV activity to levels where ethnobotanical and random collection samples were the same (Balick, 1994, p. 5). This demonstrates that perhaps these “unimportant” compounds may, in fact, be bioactive. Also, the disease definition for which a plant is used is highly dependent on the cultural definition of the disease (ibid., p. 5-6). Thus, it is important to carefully describe the disease which is being treated in order to make a reliable treatment category for the plant.

The ethnobotanical approach is specific and can reduce lots of time required for screening plants for a specific bioactivity. Selection of specific plants by a group of people for specific uses is not a random process. Plants are selected based on taste, smell, touch and other factors (Logan & Dixon, 1994, p. 28). If a plant functions or treats the patient, then it is likely that the plant will continue to be used and will become a fixed part of the phytopharmacopoeia. There is an active selection process involving the use of medicinal and food plants. Oftentimes, the selection of a food plant is tied in with its medicinal uses (Etkin & Ross, 1991). Plants which maintain or help achieve a state of health within a population, based on that population’s definition of health, is usually

incorporated as a candidate for treating disease. Plants which do not “work,” either physically, mentally, or culturally, are usually discarded.

The correlation between human use and bioactivity make ethnobotany a formidable approach in selecting plants for further research as proto-medicines. Shaman Pharmaceuticals uses the ethnobotanical approach for pharmaceutical research. Plants with specific ethnobotanical uses a subject to natural product screening methods, natural products chemistry, and medicinal analysis. In return, those who provided information about these plants are reciprocated with conventional health care and medicines to their village. Any long term benefits would also be shared with those who provided the information. Thus, proto-medicines are selected in an efficient and culturally sound method (Conte, 1996, p. 95).

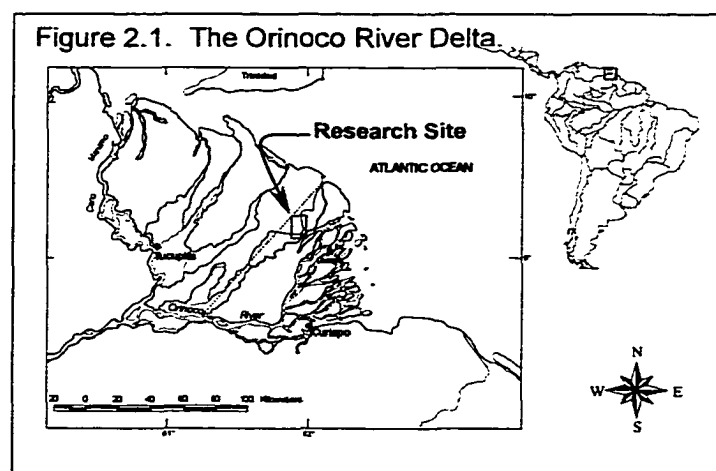
Although it is not the intention of this project to select plants for pharmaceutical research, the ethnobotanical approach is used to select a plant reported most often as a treatment for wounds by the Winikina Warao of the Orinoco River Delta, Venezuela.

Chapter 2.

The Study Site

A. The Orinoco River Delta

The Orinoco River Delta (Figure 2.1) is situated along coastal Venezuela, south of Trinidad and north of the Guayana highlands. It is a wetland built by the flow of the Orinoco River into the Atlantic Ocean (Muller, 1959; Van Andel, 1967; Vasquez & W. Wilbert, 1992). The Delta proper lies east of the Manamo River and north of the Orinoco River. It is from the Manamo and Orinoco Rivers that smaller rivers branch off, splitting the Deltaic forest into islands.



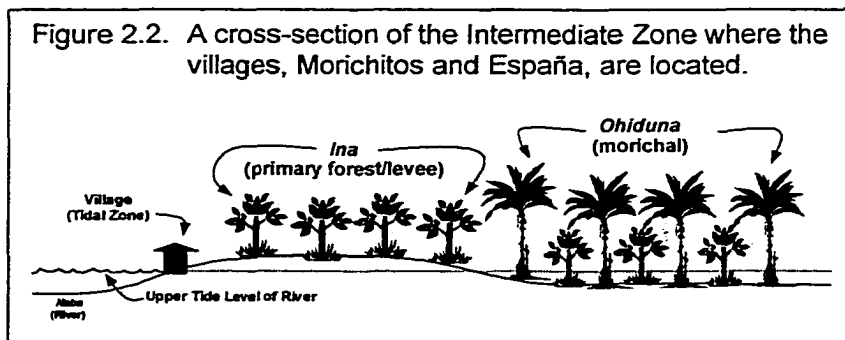
The Orinoco River Delta can be divided into three land zones: the littoral, intermediate, and pre-littoral. All land zones except for the pre-littoral zone, which is closest to the apex of the Delta, are flooded for several months during the rainy season. The littoral zone begins at the oceanfront and extends inland for 10-20 kilometers (J. Wilbert, 1979). The land is rarely above half a meter when the rivers are at high tide. Moving inland from the littoral, the land slowly rises to form the intermediate zone, where levees are 1-1.5 meters above

high tide. The study site is located in the intermediate zone along the Winikina River (see Figure 2.1). Heading toward the Manamo River and the Delta apex, the intermediate zone becomes the pre-littoral zone which is several meters above high tide. There is very little forest left on the pre-littoral zone because much of it was razed in times past for lumber. Today, it is used mainly as pasture for cattle. When the rainy season hits the Delta, the cattle must be evacuated to higher land south of the Orinoco River or west of the Manamo River due to flooding.

Rain, rather than temperature, determines the major seasons of the Orinoco Delta. The dry season (*ihabwaha*) lasts approximately from January to May and the rainy season (*hoida*) lasts from May to December. A brief dry season (*ihabwaha sanuka*) lasts from August to October breaking up the main rainy season. Dispersed throughout the year may be downpours lasting only a few minutes during the day. The study site is affected twice daily by tidal fluctuations. During the dry season, the tide may fluctuate by more than one meter.

In the Intermediate Zone, where the research site is located, small rivers break up the swamps to form islands. These Deltaic islands, which are formed in the littoral and intermediate zones, are "saucer-shaped" (W. Wilbert, 1986). The outside rim, the tidal zone, stretches only a few meters from the river's edge (Figure 2.2). This is where the villages are usually located. Moving inland from the river's edge is a levee which rises to its highest level of 0.5-1.5 m above high tide. This levee stretches inward for several hundred meters.

Primary forest is located here and is called *ina*. The levee then dips into a backswamp where oligarchic forests of the palm, *Mauritia flexuosa*, are found interspersed among other forest trees.



This is the *ohiduna* (*morichal*), an oligarchic forest made up primarily of the *Mauritia flexuosa* L. palm. Oligarchic forests are “forests dominated by only one or two trees species extend[ed] over several million hectares...and in many cases the dominant species produce fruits, seeds, or oils of economic importance” (Peters, 1992). These backswamps dry out almost completely during the dry season. During the rainy season, they fill up with water and flow over the levees, flooding even the highest levee. It was in this isolated region, the backswamps, that the original homeland of the Winikina Warao was located. Here the semi-nomadic ancestors of present day Winikina Warao foraged for food.

B. The Winikina Warao

The Warao are the second largest autochthonous indigenous group in Venezuela, following the Guahiro. They number about 20,000 of a total population of almost 107,000 in the state of Delta Amacuro (Heinen, Lizarralde, & Gómez, 1994-96). Since prehistoric times, the Warao have lived among the Arawak and Carib people throughout the region extending from Isla Margarita in

the Caribbean Sea, south to the Imataca Mountains of Guayana (Heinen, 1992; J. Wilbert, 1979, 1980b, 1996, p. 3-8). They moved into the Delta proper to escape the atrocities of the Caribs and Arawaks and, subsequently, into deeper seclusion, to escape enslavement and evangelization by those who were in pursuit of gold, slaves, and religious converts (Heinen, 1992; J. Wilbert, 1972, p. 66-67, 1996). Today, the majority of Warao reside in the southeastern region of the Delta proper, also known as the south-central Delta (Heinen, 1992; W. Wilbert, 1992).

The Warao have been reported in the literature since 1590 (J. Wilbert, 1979). Perhaps the earliest European sighting of the Warao was by Columbus on his third voyage. He mentions the Warao in his daily log as he skirted the northern rim of South America (Heinen, 1992). Columbus was the first European to set foot on the South American continent when he briefly walked on what is referred to now as the Orinoco River Delta.

The Warao traveled in bands of 20-60 people and followed a yearly migratory cycle starting with the dry season when they would collect **ohidu aru** (palm starch) from **ohidu** (*Mauritia flexuosa* L.f.) in the backswamps. Once the rainy season started, they would move to and live on the sandy oceanfront from August through September to collect crabs. They would then return to the forest and continue foraging for natural resources and, during the brief dry period, collect more **ohidu aru**. Palm starch from **yaha** (*Manicaria saccifera* Gaertn.), though not as palatable as **ohidu aru**, was available year-round and collected when necessary (W. Wilbert, 1994-96).

a. **“Warao” Etymology**

The name **“Warao”** is believed to have several origins, though the most widely accepted of these is that **“warao”** means “people of the boat” (J. Wilbert, 1972, p. 66). In this sense, it is believed that **“warao”** comes from the terms **“wahibaka,”** which means “canoe,” and **“arao,”** which means “people” (**warao**). Canoes are the only suitable form of transportation to get around the Delta due to the myriad of rivers which intersect the swamp forest. Also, because the Warao are known to be expert canoe craftsmen, the term **“wahibaka arao,”** or “people of the canoe,” is fitting.

Heinen (1992) argues that many Warao, throughout their history, assimilated with the Arawaks and Caribs along the periphery and isolated sections of the Delta. The “true” Warao migrated to the inner caños of the region between the Macareo and Arawao Rivers, which includes the study site. These Warao remain to this day the most traditional. Their seclusion inside the forest swamps made them less adept at navigating the larger rivers and, thus, their canoe craftsmanship may not have been as well developed as that of the Warao who lived in the periphery of the Delta and who had more than sporadic contact with Europeans. These secluded Warao would only travel on the larger rivers to trade their goods for tobacco, sell their crafts, and buy Western products, in the country of Trinidad or the capital of Delta Amacuro, Tucupita. Because the term **“arao”** means “people” and implies residence as well as ownership, the term **“waha,”** which means “beach, sand bank, marshland,” refers to the people who reside on the “beach, sand bank, marshlands.” Thus, Heinen states that for

these original inhabitants of the lowlands (intermediate and littoral zones), the term “**waha-arao**” or “**warao**,” is a more appropriate etymology for “**warao**.” He feels that the “people of the boat” etymology for “**warao**” is probably more recent, since the Warao adopted sedentary lifestyles. Today, the Warao live in villages along river’s edges and have to travel regularly along the larger rivers.

A third interpretation for the origin of “**warao**” comes from Delgado (1955-57) who identifies the word “**guarao**” from “**gua**” which means “to engender, generate, create” and “**rao**” which means “tree” or “people.” Thus, the term “**guarao**” could mean “the people who owe their existence to the tree” or “the people who are engendered from the tree.” This interpretation fits within Warao cosmology which views the forest as being made up of “people of the forest” (W. Wilbert, 1986). This etymology would have to be further investigated as I did not find this interpretation elsewhere. Most Warao ethnographic research after Delgado defines “**warao**” to mean either “people of the boat” or “people of the marshland.” It is difficult for me to choose which of these two widely accepted etymologies is more correct as they both seem fitting.

The largest recognizable group of Warao by the Warao themselves is the subtribe which includes two to three bands (20-60 people per band), enough to make up one village. The Warao of the semi-nomadic epoch referred to themselves by their geographic region based on a nearby river or island. Thus, the Warao who reside in the intermediate zone of the Delta along the Winikina River are known as the “Winikina” sub-group, the Winikina Warao. The subtribes that resided on *Isla Tobejuba* disbanded and established villages

throughout the intermediate zone of the Delta (W. Wilbert, pers. comm.) in the early days of agriculture beginning in the late 1920s. This was due to the establishment of a mission village on the Araguaimujo river and its overzealous, questionable missionary practices. The Winikina Warao are descendents of the *Isla Tobejuba* and *Isla Mariusa* bands.

Warao marriage is endogamous at the level of the subtribe but exogamous at the level of the band. The Warao do practice polygamous marriage but it can only occur when the woman's husband dies and she becomes the wife of her sister's husband, or if it is arranged by social agreement (Urbina & Heinen, 1982).

b. Traditional Warao Food Gathering

Retreating into the Deltaic forest meant the adoption of food gathering techniques that spelled the difference between survival and extinction. The Warao were the only South American indigenous group that adopted the extraction of *ohidu aru* (palm starch) from the pith of *ohidu* (*Mauritia flexuosa* L.f.) (J. Wilbert, 1970, 1972; Ruddle, Johnson, Townsend, et al., 1978) and to a lesser extent from the *temiche* palm (*Manicaria saccifera* Gaertn.) (J. Wilbert, 1974; W. Wilbert, 1994-96). By successfully exploiting this food source, they were able to live in this otherwise ecologically hostile environment, safe from predators, attacks, imprisonment, or enslavement by the Caribs and Europeans. These non-Warao did not believe anyone could live in the inhospitable swamp forest.

As long as the Warao can remember, **ohidu aru** has been prepared by scraping out the palm pith from the top one-third of the trunk of **ohidu**. The wet pulp is then pressed through a sieve (a basket, called **bihi**, made of woven *Ischnion* sp. plant fibers), collected into a wooden vessel (made from an excavated tree trunk), and dried in the sun. In Warao folk lore, it is believed that they learned to extract it from their Carib neighbors who no longer practice this method. It is also speculated that they may have already known this food procuring method before secluding themselves in the Delta. Prior knowledge of how to exploit this resources may have been the reason for deciding to escape to the seclusion of the Deltaic swamp forests (Heinen & Ruddle, 1974).

Two religious festivals, known as **Nahanamu** and **Habisanuka**, were celebrated to ensure the physical and cultural survival of the Warao. Large amounts of **ohidu aru** were collected and distributed to the Warao bands during the long rainy season when **ohidu** does not produce enough starch for sustenance. **Ohidu aru** collects in the palm trunk during the dry season (Heinen & Ruddle, 1974). At the start of the rainy season, palm starch dwindles as energy is relocated to producing the inflorescence and, eventually, the fruits. During the end of the dry season, the Warao collected large baskets of **ohidu aru** which was stored in a container built from plant leaves and placed in the bottom of a ritual house where the **kanobo** (gods) in the form of a stone, is kept (J. Wilbert, 1964, p. 17). Up to 1500 kg of **ohidu aru** was stored—enough to last 2-3 Warao bands through the rainy season before the short rainy season, when

ohidu aru would be available again. Unprocessed **ohidu aru** can be stored for up to four months.

There are three spiritual healers in the Winikina region. The **bahanarotu**, or medicine man, is the “owner of the **bahana**” and cures physical ailments caused by **bahana**, a sickness caused by the introduction of an object into the body of the victim. The **hoarotu**, or shaman proper, is the owner of **hoa** and cures patients who suffer from **hoa**, a sickness caused by the introduction of **hoa** essences which are the specific properties of all plants and animals. The **wisiratu**, or the priest of the Warao, is the owner of **hebu** or pain. He treats **hebu** sickness which is caused by the introduction of a supernatural essence, such as an ancestor spirit, into a person's body, thereby causing intense pressure. He is the priest because he resides over the Temple Cult. Because he alone can communicate directly with the Warao gods, **kanobo**, the **wisiratu** is ranked higher than any other member of his band (J. Wilbert, 1964, p. 17-18).

The **wisiratu** is the “physician” of the Warao. He is the keeper of the sacred rattle and the stone representing **kanobo**. The **wisiratu** smokes 1-2 ft-long cigars made of a tobacco leaf wrapped in the sheath of the apical meristem of **winamoru** (*Euterpe oleracea* Mart.), the only palm which can provide the tobacco wrap. He smokes the cigar to feed the gods. After a week of ritual feeding and communicating with the gods, he receives a vision from them. This vision comes at a time when the Orinoco River Delta is shifting to the rainy season. The rains will arrive soon and **ohidu** will no longer be able to supply **ohidu aru**. There is enough **ohidu aru** collected to placate the gods and

supply the bands. Once the *wisiratu* has fulfilled his obligation of feeding the gods with tobacco, the *wisiratu* receives the word to distribute the food to the people. The gods promise to continue to protect the Warao from the malevolence of any shaman. The *Nahanamu* festival marks this declaration and is celebrated with ritual, dance, and music for four days. (Heinen, 1975, 1982, 1988, 1992; Heinen & Ruddle 1974; Heinen, Lizarralde, & Gómez, 1994-96; Schad, 1953; Suarez, 1968; J. Wilbert, 1956, 1963, 1967, 1972, 1974, 1975, 1979, 1980a, 1980b, 1996; W. Wilbert, 1994-96).

Today, the use of *ohidu aru* as a ritual to placate the high priests, and its use as a survival food during the long rainy season, has changed. With the adaptation of rootcrop horticulture, and a sedentary way of life, the arrival of a health care clinic in the village of *Nabasanuka*, and the rapid introduction of outsiders who tried, and to some extent succeeded, to force the Warao to adopt a mainstream Venezuelan lifestyle, the religious importance of the *Nahanamu* ritual has shifted. The *Nahanamu* festival continues to be a major Warao festival practiced in the Winikina region. Large baskets of *ohidu aru* continue to be collected for this celebration. However, it is no longer a sustenance necessity. The contextual significance of the *Nahanamu* festival has evolved from being a ritual necessity to a sectarian food option (Heinen, Lizarralde, & Gómez, 1994-96).

A monetary aspect has also been added to the preparation of the festival. The main organizer of the ceremony must be compensated for his services. He makes sure there is enough *ohidu aru* and that guests are invited

from the neighboring villages. Money is also needed for gas to transport him from village to village to advertise and invite others to the ceremony.

The Winikina Warao, and those of the surrounding region, were the last of all the Warao to be brought out of their semi-nomadic lifestyle. In the 1920s, the Winikina Warao subtribe began to move from deep inside *Islas Tobejuba* and *Mariusa* to life in permanent village settlements along the river's edges (J. Wilbert, 1980a). The main reason for this move was the establishment of a permanent mission, *Araguaimujo Misión*, along the Araguaimujo River. From this base of operation, a missionary effort was carried out to concentrate secluded Warao localities along major rivers where the missionaries could have much easier access to the Warao. This over-zealous effort to "civilize" the Warao was also a period of terror for many Warao of the Intermediate Zone. Many men and women whom I have spoken with remember living in the *ohiduna* with their Warao band and having the missionaries raid their camp at night. They remember the children being rounded up and taken away to the *Araguaimujo Misión* where a school was established to teach the children in the ways of being "civilized." The children were taken away without the parent's permission. The parents were allowed to visit but only occasionally. The girls learned domestic chores and practical skills like making beds, while the men practiced agriculture and cattle raising. The children were instructed by nuns and priests who felt children needed these skills in order to be part of Venezuelan mainstream life. They felt the Warao should assimilate and practice these skills in order to stop their wild ways and settle down to a "civil" life. Domestic chores such as making

beds or ironing clothes cannot be practiced in the day-to-day life of a Warao. Sleeping is done in a hammock and electricity for an iron is scarce or unavailable. Cattle raising is not practical in the intermediate zone due to lack of pasture and agriculture is left to a rootcrop horticulture for growing *ure* (*Colocasia esculent* (L.) Schott). Many Warao men who were founders of the villages along the Winikina River were married in the mission and sent home to practice their new ways. However, having spent 8-10 years in a mission with little contact with their families who still lived inside the deltaic forest, made it difficult for these Warao to return to the *ohiduna*.

This effort to bring the Warao in line with mainstream Venezuelan society was carried out in conjunction with the government of *Territorio Federal* (Federal Territory) Delta Amacuro. *Territorio Delta Amacuro* was declared a state only in 1993. A program was initiated in the 1950s, when the Winikina Warao villages were being established, to provide free weekly transportation for 30 Warao at a time to Tucupita, the capital of Delta Amacuro. In exchange for this service, these Warao were required to go to the Tucupita hospital for a physical exam and inoculations. The government felt this was good for the Indians because they had easy access to Tucupita where they could sell their folk items and buy clothes and other goods at a lower cost than what they would have to pay the *buhoneros* (*criollos* who travel by motorized boat from village to village, selling a variety of items to the Warao at an inflated cost). Also, the government felt this would give the Warao more confidence in their government (Boletín Indigenista Venezolano, 1954).

A definitive effort by the missionaries to push the Warao into a crop-based economy was the introduction of rice as a cultigen. Several Winikina Warao informants related to me that they remember an era when their fathers cut down large tracts of primary forest on the levees (*ina*) to grow rice. Due to the crash in the rice economy of Venezuela, it did not prove profitable and was soon abandoned. Acidification of the soils (due to lack of trees) also made rice cultivation difficult to sustain over a long period of time. One Warao man of the village of Nabasanuka, Teodoro M., who is over 70 years old, fondly remembered the days of rice growing. He recalls buying the seed from an Italian man who traveled to his village on a regular basis to collect payments of rice. After a couple of years, however, the man no longer returned and rice as a Delta crop was soon abandoned.

Corn was also introduced and is grown to this day mostly along the banks of the Araguao River in the western Intermediate Zone where the ground is more elevated. Corn must be planted, grown, and sown before the dry season ends as the area is usually flooded for most of the rainy season.

A major incentive for adopting a sedentary lifestyle was the introduction of *ure* (*ocumo chino* - *Colocasia esculenta* (L.) Schott). The missions may have had some role in introducing agriculture to the Warao but the Warao who worked in the Guyana highlands were primarily responsible for introducing *ure* to the southeastern section of the Delta. *Ure* is a viable crop for the intermediate zone of the Orinoco River Delta because it has no season limitations, is well adapted to the humid ecological conditions of this region, is

easily planted, and does not require a great deal of cultivation (Heinen & Ruddle, 1974). It freed the Warao from their dependence upon the *ohiduna* and allowed them to settle permanently along the river's edges.

Lumber production was an attempt at exploiting existing Deltaic resources. A private timber company was established about 2 hr from the study site, at a point where a small branch off the Araguao River turns toward the Winikina River. The lumber mill was founded in the mid-1950s at a time when Johannes Wilbert was starting his anthropological research with the Warao of the Winikina region. The village where the lumber mill was located is called *Asseradero*, but is also known as *Winikina*. It is primarily Warao but several *criollos* who have intermarried with the Warao of this village. It has become a center of Warao-*criollo* activity, especially due to the lumber mill which operated for several years. Because so many *criollos* live there, more government services are offered, including a regular supply of oil for the electric generator and a school complete with a cement basketball and soccer court. It also boasts a long cement walkway and there is plenty of hard ground through the main path that runs through the village.

The lumber mill stimulated a cash economy by employing the neighboring Warao men on a regular basis. Some Warao men who worked in the mill have told me that when the local lumber mill was operating, it was a time of plenty for everyone. They had jobs and were able to buy flour, sugar and salt, as well as clothing (on their trips to Tucupita). In 1993, it was discovered that the owner was operating illegally so the business was closed by the *Ministerio del*

Ambiente y Recursos Naturales Renovables (MARNR). Dark days fell upon the region when the lumber mill closed. Except for paid government jobs such as electric generator operator, school transporter, police, and mayor's representative, employment is scarce. Many Warao men have taken to travelling more regularly to the urban towns of Tucupita, Barrancas, Maturín, and all points in-between. Some have traveled as far as Caracas in search of jobs and money. Today an entire family will leave to sell their folk products consisting of basketry items and hammocks. With this money they could buy food, clothing, and, when money runs out, they could beg on the streets. Desperate times call for desperate measures.

A palm heart extraction company continues to operate on the Araguaimujo River. The Warao men cut down **anare** (*Euterpe oleracea* Mart.) and prepare the palm hearts for sale to the company. The company employs a boat which travels to the villages to collect the raw palm hearts. The company buys the palm hearts in lots of 100 (1500 Bv (US\$3.00) or 15 Bv each (US\$0.30)). In its efforts to insure a constant source of **anare**, the company gives the Warao the option of planting an **anare** seedling wherever they cut an **anare** adult. This has proven problematic for the Warao because if the **anare** is replanted with a company seedling, that palm becomes property of the company. The Warao are not allowed to cut the palm unless instructed by the company. This is difficult for the Warao who must seek new land for their swiddens. If they cannot cut down a palm, which is owned by the company, they are limited in their search for new land. Thus, many Warao have chosen not to replant the palm.

The Winikina Warao are noticing that extraction of natural products can lead to a reduction of these resources. They are concerned that it is difficult to collect enough palm hearts to sell to the canning company and to make the collection effort worthwhile. They have also noticed that it is harder to find enough **anare** to build a complete house or to complete a village boardwalk. When I asked Warao men about changes in the Delta forest, they mention that it is harder to find enough **anare** for their homes and boardwalks. Exploitation of timber for thirty years has also forced the Warao to travel a long way in order to find the right tree, if one is found at all, for a canoe.

Even though the Warao notice that the trees they use for canoes no longer exist near their village, even though they acknowledge that the forest horizon is not as tall as it used to be, and even though they oftentimes cannot build a complete house or boardwalk, many of these men would gladly welcome the lumber mill again in order to gain employment.

C. Morichitos and España

The villages of Morichitos and España are located along the Winikina River. The Winikina River is a branch of the Araguaio River and runs north-south to southwest. Morichitos is located on the west side of the river and España is located about 1.5 km down river on the east side.

Morichitos was founded in 1962 by Antonio Lorenzano, village chief and **wisiratu**. The Warao translation of the Spanish word *Morichitos* is **Ohidu Sanuka** which means “small **ohidu** (*Mauritia flexuosa* L.f.) palms.” When the

village was founded, three young **ohidu** palms were planted behind the first house, hence the name **Ohidu Sanuka**. Antonio Lorenzano was a child when he was taken by the missionaries to Araguaimujo. It was there that he met his wife, Olga. He was influenced by the planting of **ure** in the land near Araguaimujo so when he moved back to Winikina, he began to grow **ure**. As he established **Ohidu Sanuka**, more family members from his band, who were still living in the forest, slowly moved into the village. The age of the semi-nomadic Winikina Warao was coming to a close. Today the village boasts a population of about 80 residents with at least 19 houses. Several families have left Morichitos to live in Barrancas but other families continue to join the village.

The selection of Morichitos as a study site was based on my own experience with the Winikina Warao of this village. I was introduced to the Warao in the Fall of 1991 by Werner Wilbert. The two Wilberts, Johannes Wilbert, and his son, Werner, have a long tradition of working with the Warao of this region. W. Wilbert introduced me to the Winikina Warao of Morichitos which made working with these Warao much easier. I was accepted quicker than if I had gone on my own.

The village of España was founded in 1957 by Inocencio Moya and Carlos Zapata. Inocencio's first wife, Josefina, died but he married again to Sinovia. The village boasts a population of 60-70 people and about 16 houses. I was able to make contact and establish ties with this village because several families of Morichitos and España are related. They are all the original

descendents of the semi-nomadic bands which traveled around *Isla Mariusa* and *Tobejuba* (W. Wilbert, pers. comm.).

The only permanent paying jobs in these villages are electric generator operator, school transporter, policeman, and mayor's aide. Other sources of income come from selling hammocks, baskets and other crafts, mostly made from the leaf fiber of *Mauritia flexuosa* L.f.. Some of the villagers of Morichitos are building adult swings made from the same palm fiber. A welfare system has also been instituted by the government of Venezuela. Mothers receive a monthly stipend for up to two children.

The only other source of income for the residents of the two villages is to travel to Barrancas or Tucupita for work. This is usually to load and unload commercial boats. Several families have left Morichitos to live in Barrancas. It is difficult to speculate whether these migrations to urban areas are permanent or not because a family may return to the village at any time. However, the longer a family stays away, the more difficult it is to return to the village. It takes 10 months to sow an *ure* crop so, in the meantime, the family's relatives must take on the burden of feeding an additional family for almost a year.

España, because it is located further down river, is a bit more isolated and more traditional than Morichitos. Several families still spend 2-3 months in the *ohiduna*, collecting *ohidu aru*. The Morichitos clan, when they go to the *ohiduna*, usually return the same day or 2-3 days later.

The Warao of Morichitos and España do not rely exclusively on **ohidu aru**, as explained in the previous section. **Ure** is the main food staple along with 1 kg bags of flour which are purchased in Tucupita or from *buhoneros*.

Fishing is another important food source. Mostly it is **osibu** (*morocoto*, *Piaractus brachypomus*) and **habahaba** (*bagre/rayao*, *Pseudoplatystoma tigrum* and *P. fasciatum*) that are popular to eat. In addition, the Warao identify 51 freshwater fish for food (Ponte Johansons, 1995). However, the Warao of Morichitos and España have noted that it is very difficult to fish around the village areas. They must travel up river a few kilometers or they go to the *Araguao* River.

The children of Morichitos go to a school located at the *Asseradero* village. The children from España go to **Kuberuna**, a village about 1.5 km down river from España. Education is sporadic, at best. It depends on availability of teachers and if there is gas available to power the motorboat that takes the children to school.

Although access to Western goods is easier, the Warao of this region continue to maintain a traditional lifestyle. However, the influence of outside goods and services has put many residents in a tail spin. I feel that many Warao from these two villages are teetering between the old and the new. They discard the old for the new but, because of the isolation and poor economic strength of these villages, the new is not as accessible or it is expensive so interest in the new eventually wanes and dissipates. The Warao are then left

without their traditional cosmology and without the new ways. They need help to complete the leap from semi-nomadic foragers to agriculturists.

D. The Warao *Daukaba* (swidden)

Agroforestry is being practiced to some extent by contemporary Winikina Warao. Agroforestry has been defined as a “sustainable management system that combines agriculture and/or livestock with tree crops and/or forest plants on the same unit of land, either simultaneously or sequentially” (Denevan & Padoch, 1988). Dufour and Wilson (1994, p. 121) put it more succinctly when they described the Warao as “rootcrop horticulturists.” The Warao grow a few subsistence crops in swiddens called ***daukabas***. During my preliminary visits to Winikina Warao territory, I collected ethnoecological information on ***daukabas*** because I wanted to know if there was any intentional planting of medicinal plants by the Winikina Warao in the ***daukaba*** as is done by other indigenous groups in South America (Denevan & Treacy, 1987). If they were planting medicinal plants then I could carry out the “inventory/interview” method as is popularly used in many ethnobotanical studies today. That would not be the case for this study.

Indigenous inhabitants of Neotropical forests, in many cases, utilize their forest home for sustenance in a sustainable manner so that it continues to provide a bounty (Denevan & Treacy, 1988; Paitán, 1988). Managed swiddens and fallows have been found to be an important part of species biodiversity conservation (Eden & Andrade, 1987; Lugo, 1988). The Winikina Warao are

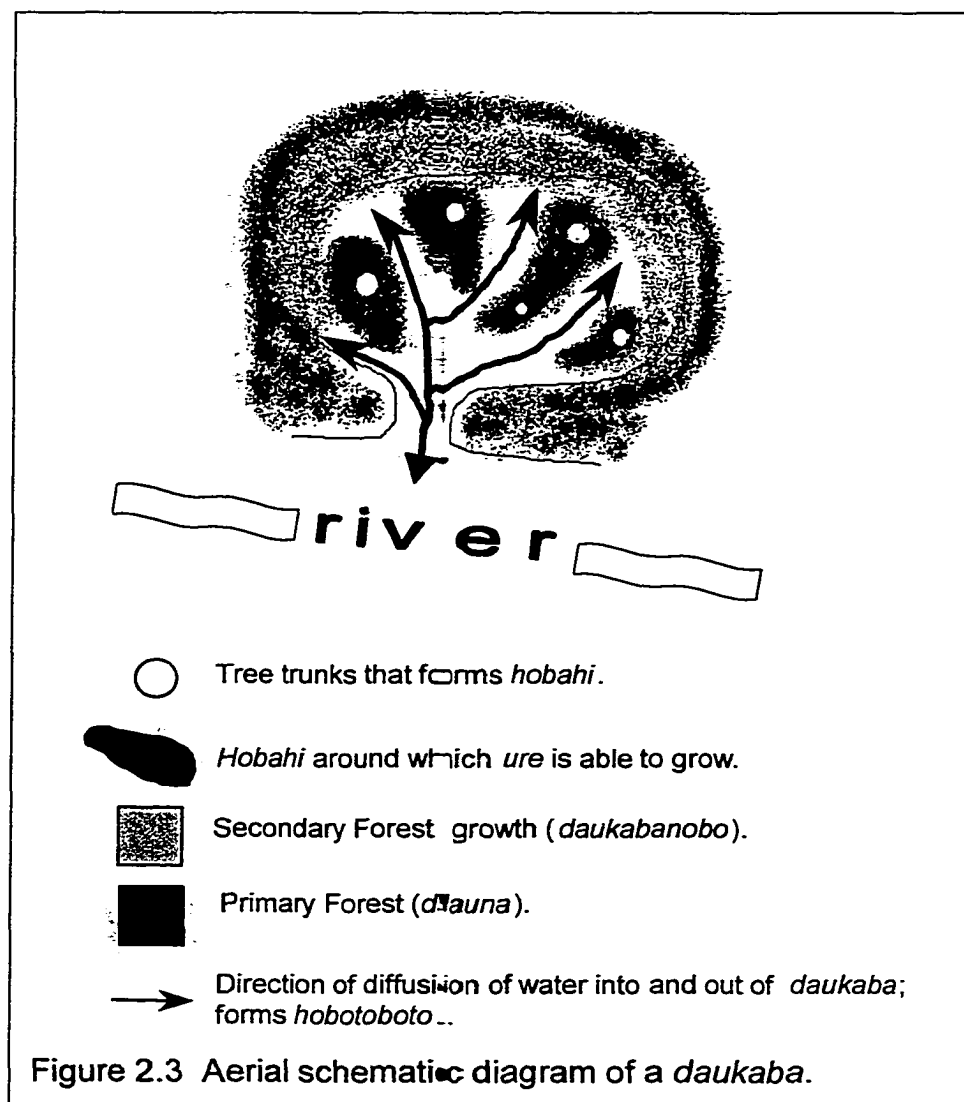
relative newcomers to agroforestry and little is known about their utilization of the surrounding forest. There has been speculation that the Winikina Warao may have managed their plant resources in the past. The appearance of **ohidu** (*Mauritia flexuosa* L.f.) growing where a primarily mangrove population (*Rhizophora mangle* L.) should exist in the lower intermediate zone of the Orinoco River Delta may indicate that palms were actively managed by the Warao to allow easy access to its food source and other raw products (Heinen, San José, Arias, et al, 1995). However, this may only be incidental because the Warao carry the **ohidu** fruits to the village, eat them, and throw the seeds on the ground around the house. Thus, palms growing on the river's edge, instead of deep inside the **ohiduna**, may be an indication of Warao having inhabited that area, rather than implying that the Warao manage **ohidu**.

a. **Daukaba** site selection

A good location for a **daukaba** is in the **ina** (primary forest), because there is more **hobahi** (land surrounded by water) available for cultivation. If primary forest is not available, then a fallow, **daukabanobo**, covered with secondary forest growth, is the next best choice. Today, **daukabanobos** are usually the only area available for **ure** cultivation in the region immediately surrounding the villages. As more and more **daukabas** are created, less and less primary forest is available near the village. **Daukabas** constructed a long distance from the village are not favored because vigilance of the **daukaba** becomes difficult. The crop is vulnerable to predation by **chiguiri** (*Hydrochoerus hydrochoeris*), peccary (*Pecari* sp.), tapirs (*Tapirus terrestris*),

deer (*Odocoileus virginicus*), and other Deltaic fauna that enjoy the taste of young *ure* plants.

Smaller rivers branch from the Winikina River, moving water into the surrounding forest. This water flows into the *daukaba* during high tide and flows back out during low tide (Figure 3.1). Because of this daily flux of water, a *daukaba* should have enough aerable land that it is not greatly



affected by daily tidal fluctuations. Sites that have a number of *yaha* palms (*Manicaria saccifera* Gaertn.) or other large trees such as *bihibihidu* (*Pentaclethra macroloba* (Willd.) Kuntze) and *omoru* (*Symphonia globulifera* L.f.) are preferred because the higher elevation of land around the base of the trunk

makes this patch of land drainable on a daily basis. This raised ground is known as **hobahi**, “land surrounded by water.” A *temiche* palm raises the land around it and creates useable land called **yaha ahobahi**. *Ure* (*Colocasia esculenta* (L.) Schott) is planted in clumps around the **yaha ahobahi**.

Areas within the **daukaba** that are permanently saturated with water are called **hobotoboto** and are not cultivated. The word **ho** means “water.” W. Wilbert (1995) suggests that the Warao word **boto** comes from **botonai** which means “rotten,” a description pertaining to the **hobotoboto’s** smell of rotting vegetation. If one is to accidentally step in the **hobotoboto**, the person will sink into the soft mud up to the knees or as far up as the waist. This has happened to me on a few occasions.

Because the Winikina Warao have only recently been introduced to agriculture, the concept of planting something for the purpose of regeneration is still a relatively unknown concept. The Warao know that planting is important, they do this with **ure**. However, they do not see themselves practicing agriculture with wild plants. They believe the forest provides plenty and so they do not have to bother planting trees or plants that grow wild in the Deltaic forest.

While walking through one of the swiddens on my most recent trip to the Winikina region, I ran across a **murusi** (*Renealmia alpinia* (Rottb.) Maas.) plant growing in the secondary forest growth. Tirzo, my collaborator, informed me that this was an important plant. Its fruits were used to dye **ohidu** fiber but, more importantly, women use an infusion of the leaves to bathe their newborn

children so they do not fall ill. He stressed that it was a very important plant for the Warao. I suggested that he plant it close to where he can have easy access to it. Perhaps other *murusi* plants will also grow around it. He thought it was a good idea. We transplanted it in the back part of his house, an area clear of trees but which is very soft, especially after a rainfall. The next day he approached me and said that the thought of planting *murusi* so close to his home had never occurred to him but it was a good idea.

Winikina Warao cosmology maintains that the Warao live on a large disk surround by water (*hobahi*) and they are at the center of this disk (J. Wilbert, 1979). When digging a hole in the ground of the Delta, water immediately fills it up. Thus, it is easy to understand the Warao idea of land/disk floating on water. Winikina Warao cultural traditions are intimately intertwined with water. The Winikina Warao world, as well as Winikina Warao life, means to be surrounded by water. Thus, it is a fitting analogy that the *daukaba* is made up of *hobahi* on which *ure* can be planted to provide food. For it is only here, on the *hobahi*, that life, in the form of *ure*, is provided today.

b. *Daukaba* preparation

The site selected for a *daukaba* is usually cleared in January or February to coincide with the start of the long dry season. However, several sites can be prepared and staggered until the beginning of the rainy season in May to insure a regular supply of *ure*. A second period of site selection can take place during the short dry season from August to October. All vegetation, from small herbaceous plants to large trees, is cut down to create a shade-free

environment. The trees, which serve as ***hobahi***, are cut down but their stumps provide the elevated ground necessary for a successful ***ure*** crop. Occasionally, an ***ohidu*** palm may remain but no other trees are left standing. This allows the maximum amount of sunlight to enter the ***daukaba*** because, as one Warao stated, “***ahaka hokohi obonoye***” (air and sun are essential) for ***ure***. The debris is left for 1-2 weeks until it is dry enough for burning. A good burn is one in which most vegetative matter is burned off. If the burn is not adequate, the owner will most likely have to weed the ***daukaba*** throughout the productive cycle of the ***daukaba***, a tedious and time-consuming task. Primary or secondary forest surrounding the ***daukaba*** helps prevent the clearing fire from spreading to other sites.

After the burn, clearing the debris in the ***daukaba*** takes a few days. The smaller trees are either moved to one end of the ***daukaba***, or dropped into the river. The larger trees, which are too big to be moved, remain in place. They serve as bridges over the ***hobotoboto*** and facilitate movement across the ***daukaba***. They may also serve as a source of fertilizer as they slowly decay into the ***hobotoboto***.

c. Swidden transects

In order to determine if the Warao actively select forest plants for cultivation in and around the swidden, I carried out transects in 22 swidden-fallows located along five different rivers. A rope with 1 m marks was stretched the length of the longest distance from one end of the swidden to another, up to 50 m. An inventory was then taken by counting the plants 5 m to the left and

right of the rope for the entire length of the transect. Cultigens were identified with common names and their uses described in the field. The owner of the swidden was identified and the age of the swidden provided by Winikina Warao informants (Table 2.1). Casual, open-ended interviews were carried out with several owners of the swiddens in order to learn about *daukaba* preparation.

Table 2.1. Transect data from 22 *daukabas* in the Winikina region of the Orinoco River Delta.

DAUKABA AGE (months)	OWNER	V ¹	CAÑO ²	Length of Transect (meters)
New	Evelio R.	M	Tarasona	—
2	Ravel R.	M	Tarasona	36
4	Alicio P.	M	Winikina	38
4	Santiago R.	B	Yaruara	38
5	Tirzo R.	M	Morinoko	53
6	Nicasio R.	M	HAB	—
8	Florindo L.	M	HAB	23
8	Maximino V.	M	Winikina	—
8	Tirzo R.	M	Winikina	28
8	Bernardo R.	M	Yaruara	29
9	Rodrigo M.	B	Morinoko	36
9	Estanilou R.	B	Tarasona	—
12	Alonso R.	M	Winikina	43
18	Hermenildo R.	B	Morinoko	23
18	Francisco G.	B	Yaruara	42
18	J. Pepito T.	M	Yaruara	32
24	J. Israel R.	B	Morinoko	29
24	J. Israel R.	B	Morinoko	26
24	Evelio R.	M	Tarasona	35
30	Segundo R.	M	Morinoko	—
30	Gilberto Q.	B	Winikina	42
36+	Segundo R.	M	Morinoko	100

¹V= village (M = Morichitos, B = Barranquilla); ²HAB = Hemuru Akoho Borohoy

The main purpose for preparing a ***daukaba*** is to grow ***ure***. As stated earlier, it has no season limitations, is well adapted to the humid ecological conditions of this region, is easily planted, and does not require a great deal of cultivation (Heinen & Ruddle, 1974). Other crops planted in the ***daukaba*** include three varieties of sugar cane (*Saccharum officinarum* L.: ***sicaro simu***, ***sicaro hoko***, and ***sicaro habahaba***); four varieties of bananas (*Musa* spp.: ***buratana basabasa***, ***buratana harahisa***, ***buratana kobenahoro***, ***buratana kobokobo ayabe***); and yucca (*Manihot esculenta* Crantz.: ***aru hebuho***) (Table 2.2). These crops are planted to a much less extent than ***ure*** because of their intolerance to flooding and water salinity.

Table 2.2. Number of *Colocasia esculenta*, *Saccharum officinarum*, *Musa* spp., and *Manihot esculenta* plants for each of the 22 *daukabas* in the Winikina region of the Orinoco River Delta.

Fallow Age (months)	No. of <i>Colocasia esculenta</i> plants	No. of <i>Saccharum officinarum</i> plants	No. of <i>Musa</i> spp. plants	No. of <i>Manihot esculenta</i> plants
New	—	—	—	—
2	256	—	4	—
4	416	—	—	—
4	270	3	1	2
5	340	7	—	—
6	130	14	9	—
8	257	—	—	—
8	172	4	—	—
8	115	8	—	—
8	101	2	3	1
9	250	16	2	—
9	315	—	5	—
12	26	1	—	—
18	188	—	—	—
18	520	—	—	—
18	140	—	—	—
24	21	—	—	—
24	103	1	5	—
24	253	2	8	—
30	145	—	3	—
30	15	—	8	1
36+	50 ¹	—	10	—
TOTAL	4083	58	59	4

¹Seedlings to be used for planting in another *daukaba*.

No medicinal plants are deliberately cultivated in the *daukaba*.

Although *yaha* and *bihibihidu* are used as medicinal plants by the Winikina

Warao, they also serve as markers for selecting a **daukaba** because they provide **hobahi** for planting **ure**.

The data in Table 2.2 demonstrates that the most prominent crop grown in the swidden is **ure**. **Buratana** can remain in the swidden long after it has remained fallow. **Sicaro** does not offer much in terms of nutrition but is still grown for its sweet taste. **Aru hebuho** is very sensitive to the flooding nature of the swiddens so is rarely found growing in the swidden. Only in the older swidden, higher off the river, is this plant a viable crop in the Delta.

E. Ure: *Colocasia esculenta* (L.) Schott

The main crop grown in the **daukaba** is **ure**, *Colocasia esculenta* (L.) Schott. *Colocasia esculenta* belongs to the Araceae Family (Plucknett, 1970, 1983) and is one of 7-10 species in the genus *Colocasia* (Colocasioideae). Many varieties of *C. esculenta* are known (Plucknett, 1970, 1983). *Xanthosoma saggitifolium*, another edible aroid of the Araceae, is similar in size and morphology to *C. esculenta*. However, the latter is of Old World origin and the former is of New World origin. Although *Xanthosoma saggitifolium* is similar to *Colocasia esculenta* and is native to the Neotropics, it is not used by the Winikina Warao and was not found growing in any of the **daukabas**. As stated earlier, **ure** was introduced by Warao who had worked in the Guyana highlands, where it is extensively cultivated.

The peltate leaf in *Colocasia* spp. and the saggitate leaf in *Xanthosoma* spp. are the main distinguishing morphological feature between the

two species, which look very much alike. A further distinction is the excretion of milky sap by *Xanthosoma* leaf blades. The inflorescence can also be used as a distinguishing character but is rarely found in field collections. Pollen may help differentiate *Colocasia esculenta* from *Xanthosoma sagittifolium* (Grayum, 1992, p. 29-31) although, as stated above, finding a fertile specimen of either plant is highly unlikely.

Colocasia esculenta originated in Southeast Asia and is reported to be one of the first crops cultivated by humans (Bown, 1988). Its cultivation spread eastward from India to Japan and the Pacific (including Hawaii, New Zealand, New Guinea, and Polynesia). Cultivation of *C. esculenta* also moved westward from the Mediterranean, across Africa, and into Europe. Colonists and slaves eventually introduced it to the New World (Greenwell, 1947; Plucknett, 1976) where it has become an established food crop throughout Latin America, including México (Alcorn, 1984), Panama, and Costa Rica (Hazlett, 1986), and Nicaragua (Coe & Anderson, 1996). It is also used as a rootcrop food source by the Pumé of southern Venezuela (Gragson, 1997), the Ka'apor of Amazonia (Balée, 1994) and the Siona-Secoya of Eastern Ecuador (Vickers & Plowman, 1984). It is a widely accepted crop due to its tolerance of high amounts of water (Coursey, 1968), a feature of primary importance in the Orinoco River Delta.

a. **Ure harvests**

There are two **ure** harvests available for each crop cycle. The first harvest, **ure namona hidu** ("metamorphosis of **ure** into a new corm"), comes approximately eight to ten months after planting the vegetative seedling (**ure a**

yaba). The largest corms come from the first harvest. They range from 25-35 cm long and weigh as much as 2 kg. The corm is plucked out of the ground complete with stems and leaves. The cormels growing around the primary corm are detached and replanted in the ground. As new secondary vegetative growth begins, the older stems rot and fall off.

Corms, with stems attached, are taken to the village for preparation. At the **hanoko** (house), the corm is cut away from the petiole. The stems, or **ure a yaba** (seedlings), are stacked on one side of the **hanoko** for future use. The **ure a yaba** can be planted around the **hanoko** for vegetative propagation until they are needed. Once these vegetative plantings are large enough, they are transferred to a new **daukaba** for the next planting.

The second harvest follows two to three months after the first. The corms are smaller than those from the first crop and are known as **ure anaboida** (secondary corm harvest from **ure**). Only these two harvests give the best yields. Cormels which are not used or missed during harvest will grow indefinitely in the swidden land fallow. **Ure** plants growing throughout the secondary growth vegetation are potential propagates for a future **daukaba**.

b. **Ure consumption preparation**

Almost all members of the aroid family contain minute crystals of calcium oxalate distributed throughout their tissues. These crystals are the main reason for the irritating quality found in many Araceae species (Dring, Kite, Nash, et al., 1995). This compound is found in the *Colocasia esculenta* corm, making

boiling a requirement for its consumption (Plucknett, 1983). Although petioles and leaves of *C. esculenta* are edible when properly cooked, only the corm is eaten by the Winikina Warao. The stem sap is used by the Warao as a treatment for wasp stings (W. Wilbert, 1986; personal field notes). The stem is cut in half and the sap placed directly on the welt.

The woman of the house prepares the corms by peeling away the hard outer, brown layer with a machete. The white inner portion, the ground parenchymal tissue, is cut into blocks for cooking. They are placed in a kettle of boiling water along with a fish popularly used by the Warao, *osibu* (*morocoto*—*Piaractus brachypomus*), when available. The fish is cleaned and placed over the *ure* blocks in the boiling water. In the process of cooking, the corm color changes from white to a light, creamy purple-blue. The texture and taste are similar to that of a potato although *ure* is sweeter. The blocks are distributed to the family and guests and eaten without utensils. A creamy mixture of cooked *ure* and water is prepared for children who have recently been weaned from breastfeeding. *Ure* with morocoto is a delicious meal, the “food of life” for contemporary Winikina Warao.

The relatively high nutritional value of *ure* makes it an excellent substitute for *ohidu aru*. It has five important fatty acids, vitamins A, B, C and E, and various essential amino acids (Standal, 1970; De La Pena, 1970). It is comparable in nutritive value to other tuber and root crops such as cassava, yams, potato, sweet potato, and cereal crops such as rice (NAS, 1975).

It was necessary for the Warao to have a stable food source in order to adopt a sedentary lifestyle. **Ohidu** was relatively easy to obtain and could supply food at definite periods of time. However, this meant the Warao had to live in the **ohiduna** for long periods of time. Also, if there was an unusually high amount of rain for one season—which occurs once every 4-5 years—then there would not be enough **ohidu aru**, causing famine for the Warao. The **ure** crop is relatively reliable though a crop can be destroyed due to high water salinity during a long dry season which also occurs every few years.

Ure, and to a much lesser extent **sicaro**, **buratana**, and **aru hebuho**, are planted in the **daukaba**. In comparison, south of the Orinoco River, land is much higher, and dikes, introduced from Guyana, have been built to provide a wider variety of food crops. I have spoken with Warao men about the possibility of creating similar dikes in the study region. The idea is appealing but would require a lot of experimentation as to the best way to build them while maintaining minimal disruption to the environment. It would also require lots of teamwork to build and maintain the dikes. The introduction of dikes in this region of the Delta would require collaboration between ethnobotanists/scientists and villagers who would work together to improve agriculture in a culturally and environmentally sensitive manner.

F. Warao Pneumatic Theory of Illness

For the Warao, a healthy person is one who has strong blood. If a Warao's blood becomes weak, it is susceptible to invasion of malevolent spirits

or odorous pathogens. Warao disease categories are divided into two groups: those having either an endemic or an exotic etiology. Endemic diseases are the result of supreme ancestral spirits, the high priests, who punish the Warao for taboo violations, from object intrusion from a shaman who protect the subtribal territory from invaders, and from bush spirits who can cause psychological disturbances (W. Wilbert, 1996, p. 372). Exotic diseases are of recent origin and were introduced through contact with Europeans (J. Wilbert, 1983; W. Wilbert, 1996, p. 372). As explained earlier, even in their isolation from the outside, some Warao men traveled north to Trinidad or south to Georgetown in Guayana to trade their goods for tobacco and other supplies, or to work. They often returned infected with arboriviruses, and other illnesses, that may have been powerful enough to destroy an entire band, or even a subtribe. Fortunately, owing to their low population numbers and isolation, a chain of infection was usually prevented. The Warao lived in small bands of 20-60 people and had a high (50%) mortality rate. Also, the fear of contagion and sorcery that could be inflicted by a shaman from another band kept the bands apart except during important religious ceremonies. It was during the *Nahanamu* festival that they came together to form groups of 200-250, and then only for a short time. Such a low population density, travelling from place to place as semi-nomadic foragers, and little contact with others assured their relative immunity from diseases, and prevented diseases from spreading (J. Wilbert, 1983).

Natural diseases, those of non-spiritual aggression, are believed to be caused by a pathogenic odor that has attached itself to the air, a liquid, or a

solid, and has gained entry into the body via the mouth, nose or skin. A disease-state occurs when this pathogenic odor dislodges itself from its carrier and spreads as a noxious gas to specific parts of the body depending on the fetid gas affinity. An herbalist, *yarokotu arotu*, provides an herbal remedy, a plant with a fragrant odor. The plant remedy enters the body of the patient through the skin as a salve or compress, the nose as an inhalant, or is ingested via the mouth. This denser gas, the fragrant odor, dislodges the fetid gas which leaves the body through one of the portholes mentioned above. The fetid odor retreats to the underworld in the West or invades stagnant water or pools of decaying debris (*hobotoboto*) where it will await another victim. The fragrant air also leaves the body and mixes with atmospheric air in the East. Health is restored when the Warao body is in an inodorous state (W. Wilbert, 1986, 1987). This is the Warao pneumatic theory of illness as put forth by W. Wilbert (1986).

The dislodging of the fetid odor by a fragrant odor is an allopathic approach to healing: the treatment of a disease using therapeutics that produce effects different from or antagonistic to those produced by the disease (Dorland's Pocket Medical Dictionary, 1982; Guralnik, 1979). Odor is a major component of both illness and antidote, making the selection of plants less likely to be random. Warao selection of plants based on benevolent odors is in line with Logan and Dixon (1994) who state that "people target only certain species [of plants] for inquiry and eventual use for they, unlike countless others, are somehow distant or unusual" (p. 26-27). This selection can be based on odor, morphology, color, ubiquity, taste, or some anthropomorphic quality attributed to the plant (Logan &

Dixon, 1994, p. 27). Preliminary biological activity research already conducted on select medicinal plants used by the Warao (Beloz, 1992; W. Wilbert & Haiek, 1991) demonstrates that biological activity of Warao plants corroborates their ethnobotanical use as medicines.

The Warao of three distinct regions of the Orinoco River Delta (including the study site) are reported to use a total of 100 plants for 256 simple and compound medicinal plant remedies (W. Wilbert, 1986). This rich phytopharmacopoeia offers the Warao a good sized arsenal to combat a wide variety of illnesses. The Winikina Warao use certain plants in the Orinoco River Delta because they provide a useful function in their society. In the case of medicinal plants, they usually do not select plants based on a "Doctrine of Signatures." Doctrine of Signatures is based on a belief that plant use corresponds to outward appearance of the body part of the plant (Raven, Evert, & Eichhorn, 1992, p. 300). In a land that is ecologically hostile and where illnesses, such as diarrhea, grippe, and fever, can mean death if not treated effectively or in a timely manner, knowing how to use the natural surroundings for survival is tantamount to choosing between life and death. Plants with medicinal uses are likely chosen because they work.

W. Wilbert (1986) has pointed out that there are differences in use of medicinal plants among different levels of acculturated Warao. For instance, more traditional Warao who live in the intermediate zone away from mission villages have more plant use knowledge compared to Warao who live in villages located in or near the mission villages. For this reason, the villages chosen for

this study are located far enough from mission influence that many traditional customs are maintained and knowledge and use of plants as medicines is greater than a more acculturated village.

G. Collection Permits

The main purpose of this project was to use an ethnobotanical approach to study plant use by the Warao. The question that I wanted answered was, "Do the plants that the Warao say they use to treat certain illnesses truly work when tested under controlled conditions?" I used a questionnaire to ask about specific plant use in order to select the plant reported most often as a treatment for non-venomous laceration wounds. I would then submit the plant to an assay that would measure certain variables that indicate wound healing efficacy. If the results were positive, that the plant part increases wound breaking strength when compared to the control, this would confirm the wound healing use of that plant. I would then go back to the Warao and report to them that, in this case, their plants do work. In the long run, this same approach, modified if necessary, could then test for the efficacy of other plants with specific use values. I envisioned that, in the long run, these plants could then become part of a healing regime in health clinics, especially in the village of Nabasanuka, which is closest to the Winikina Warao, and which has a government health clinic. If a designated health clinic is not located directly in the village, then a healing center could be formed where several of the villagers partake in health care of their fellow villagers. These "healing centers" would incorporate traditional, as well as conventional, approaches to healing. It is clear from this

description that the purpose of this project was not to “discover” new medicinal plants but to validate medicinal plants used by the Warao as a complementary health care resource.

During my preliminary field work, I also planned to compile a complete list of all plants used by the Warao of various regions in the Delta. Because of the problems I encountered in obtaining plant voucher collection permits from the *Ministerio del Ambiente y Recursos Naturales Renovables* (MARNR) in Venezuela, I had to alter my objectives if I was to carry out a successful ethnobotanical project. This change was mainly due to the MARNR's system of enforcing intellectual property rights laws as outlined in *Decisión 391, Régimen Común sobre Acceso a los Recursos Genéticos*, of the *Gaceta Oficial del Acuerdo de Cartagena*, Año XII, No. 213, July 17, 1996 (Appendix C). The *Departamento de Vegetación* (Department of Vegetation) of MARNR was the office handling plant collection permits. Amidst the quandary of defining different types of plant collection projects and what types of permits to issue for each kind of project, an indefinite hold was placed on all plant voucher collection permit requests, including mine.

Although I had a collection permit for my preliminary research, when I moved to Venezuela to begin the actual research project (Academic Year 1998-99), I was denied plant collection permit renewal privileges because of the change in policy regarding collection permits at the *Fundación Instituto Botánico de Venezuela Dr. Tobias Lasser*, the national herbarium of Venezuela. The

jurisdiction of plant collection permits was handed over to the *Departamento de Vegetación* of MARNR. Although I struggled for several months with the MARNR, there was always a new requisite or detail that had to be completed before my application for a Contract of Access could be granted. Unfortunately, the *Departamento de Vegetación* was new to the process and I, along with another Fulbright student who was doing ethnobotanical research in Amazonas, were left to wait. At the time of review of my project by the Committee of Contracts of Access to Genetic Resources at MARNR, I was treated as a pharmaceutical company in search of prototype medicines even though I had different goals than those of a pharmaceutical company or a drug discovery project.

Fortunately, all was not lost. Under the advice of my Venezuelan advisor, Dr. Fabian Michelangeli, I changed my status at the *Instituto Venezolano de Investigaciones Científicas* (IVIC) from visiting scholar to graduate student (which was more appropriate) (see Appendix A). This allowed me to carry out my basic research plan because I was under the tutelage of an IVIC investigator and IVIC is a branch of the Ministry of Public Health. Unfortunately, plant voucher collection permits were out of IVIC's jurisdiction.

The project continued, albeit with modifications. All the plants I used for the questionnaire were well known Warao plants whose names were unique to that species. As W. Wilbert stated, "previous field experience had taught me that the Warao do not apply the same name to more than one

species" (1994-96). Also, once I selected the 18 plants to be used for the questionnaire, I verified their identity with Dr. W. Wilbert's own voucher specimens deposited at the *Herbario Ovalles* of the *Universidad Central de Venezuela* (Table 2.3).

Table 2.3. Plants used for the questionnaire and the voucher specimens (W. Wilbert, collector) to which they pertain at Herbario Dr. Victor Manuel Ovalles, Universidad Central de Venezuela (MYF).

<u>Common Name</u>	<u>Scientific Name</u>	<u>Voucher Number</u>
Mango	<i>Mangifera indica</i> L.	88344
Usiru*	<i>Spondias mombin</i> L.	68313
Hemuru	<i>Montrichardia aborescens</i> (L.) Schott	88364
Idu	<i>Ceiba pentandra</i> Gaertn.	88366
Homoarao	<i>Pachira aquatica</i> Aubl.	28473
Sibu	<i>Protium guianense</i> March.	68331
Ohoru*	<i>Symphonia globulifera</i> L.f.	68320
Korokororo	<i>Hernandia sonora</i> L.	68314
Nasinaba	<i>Ocotea</i> sp. Aubl.	78336
Bihibihidu*	<i>Pentaclethra macroloba</i> Kuntze	68324
Iburu	<i>Pterocarpus officinalis</i> Jacq.	68317
Kuahineru	<i>Pterocarpus</i> sp. Jacq.	88352
Samariya*	<i>Cedrela fissilis</i> Vell.	78338
Anare*†	<i>Euterpe oleracea</i> Mart.	88349
Winamoru†	<i>Euterpe precatoria</i> Mart.	78339
Yaha†	<i>Manicaria saccifera</i> Gaertn.	78341
Ohidu*†	<i>Mauritia flexuosa</i> L.f.	78340
Murusi*	<i>Renealmia alpinia</i> (Rottb.) Maas.	6837

Also, I had the privilege of working with Tirzo Rivero, a Winikina Warao collaborator who has worked with W. Wilbert for over 15 years and is an expert in Warao plants. Although I did not collect a voucher specimen, I was well assured

of the identity of the plants I used for my project because of my previous field work and because of the meticulous notes left by W. Wilbert on his voucher specimens. I also spoke with and compared notes with W. Wilbert.

This was a true “salvage ethnobotany project” because I took a closer look at ethnobotanical information that had already been gathered for the Winikina Warao. I was going to work with plants that had already been described for ethnobotanical uses and for which vouchers already existed.

H. Summary

As the Winikina Warao become more exposed to non-Warao goods and services, they adopt them into their culture which, in some cases, replaces older, traditional customs. Although these new adaptations may be beneficial (e.g., planting *ure* in swiddens), oftentimes they may, in the long run, prove to be detrimental (e.g., replacing traditional plant use knowledge with western therapeutics in an area where access to health care is difficult, professionals are lacking, and medicines are scant or past their expiration date).

The closest clinic to the two villages under study, Morichitos and -España, is *Medicatura Herbig*, located in the mission village of **Nabasanuka**. It is several hours away from the two study villages if one travels by canoe without outboard motor. If there is an outboard motor, fuel is not usually available to power the motor. If a visit to the clinic is made, there is usually no physician or qualified paramedic available. This latter obstacle may be changing. A recent

effort has been made by the Delta Amacuro state government to train volunteer Warao as paramedics so that the clinic could be staffed at least part of the time.

Another problem the patient may encounter when going to *Medicatura Herbig* is that few medications are available, and those that are available are not the ones needed or have long passed their expiration date. This was confirmed first-hand during a visit to *Medicatura Herbig*.

If there are no medications available, a written prescription is given to the patient to be filled in Tucupita or Barrancas, a port town near Tucupita. To obtain the medication, the patient, family member, or friend, has to wait until there is transportation to that town from the lower Delta. This can sometimes take several days. The cost of a trip, \$20-30 (about 2-3 weeks wages in Barrancas or Tucupita), far exceeds the cost of the medication. Because there is no direct boat service to Tucupita, one has to arrive and depart from a port called El Volcan, about 5 kilometers south of Tucupita. This means taking a taxi from the port of El Volcan to Tucupita. Taxi and food costs for several days while waiting to return home incur additional costs onto the medication. If a friend or relative is making a pre-planned trip to Tucupita, then he/she can pick up the medication for a share of the cost of the trip and additional expenses, plus the cost of the medication.

Getting a medication could mean waiting days to weeks and spending large amounts of money. This makes access to medications in the Delta almost impossible. This is the modern health care system operating in the

far reaches of the Orinoco River Delta. The Winikina Warao are teetering between a modern and traditional world. On the one hand, many modern accoutrements can be easily assimilated without much disturbance into Warao cosmology. But forgetting the use of medicinal plants, on the other hand, in light of the modern health care system described above, is proving detrimental.

As previously stated, my interest in focusing on wound healing plants was not in discovering a new medicinal plant. I also did not carry out this project to analyze medicinal plants that may be of interest to pharmaceutical companies. Besides, wound healing products hold little interest for pharmaceutical companies. Only three wound healing products have been released to market from natural products from 1983 to 1994 (Cragg, Newman, & Snader, 1997).

I wanted to demonstrate that medicinal plants reported to be used by the Winikina Warao are efficacious for the use for which they are reported. This, in turn, could demonstrate to the Winikina Warao that the plants they use have been “proven” and thus they could be encouraged to maintain, rather than discard, their use knowledge of medicinal and other plants. De Smet & Rivier (1989) believe that those who use traditional medical practices can benefit from the evaluation of their traditional plant remedies. This evaluation can lend greater credence of efficacy for those plants which are clinically effective and they can discard those that are harmful. This evaluation could also help to improve how the plant is used if indeed it is effective.

Knowledge of useful plants could have changed by being either lost or replaced by another plant. Through my own field work I had found that the Winikina Warao do not use medicinal plants as often as what I expected. The Winikina Warao have asked me why they should bother going into a forest to collect a plant and prepare it when they can take a ready-made pill. However, lack of access to pharmaceutical drugs, few trained health care professionals, and outrageous financial costs to obtain appropriate medications makes this option a precarious one for the Winikina Warao.

By the start of my field data collection, I had 1) established a good working relationship with the Winikina Warao, 2) familiarized myself with their customs, plant use, and health information, and 3) found out that they do not cultivate medicinal plants in the *daukaba*. After taking into consideration the legal aspects of this research, I embarked upon the data collection. I used a questionnaire that would allow the Winikina Warao themselves to select a wound healing plant used for wound healing from a select group of plants already known to be used by the Warao. I also wanted to measure the plant's wound healing ability using *in vivo* bioassays by collecting samples of the part of the plant reported and measuring its efficacy when compared to a control group.

Chapter 3.

Questionnaire Introduction

A. Questionnaires

Questionnaires are tools used to collect quantitative data from a population in a consistent, accurate manner so that it could be analyzed and inferences made with reasonable accuracy about that population (Aday, 1989). The questionnaire developed for this study is a cross-sectional survey made up of both open- and closed-ended questions designed to collect information from the Winikina Warao of two villages about their ethnobotanical knowledge of specific plants and plant parts chosen by the investigator. Open-ended questions allow respondents to answer in any way they believe is relevant to the question (Aday, 1989, p. 140). Open-ended questions were used for self-identification, time living in village, and knowledge and uses of plants and plant parts. Closed-ended questions provide the respondent with a fixed set of responses from which to use (ibid.). In the questionnaire used for this study, these type of questions include asking about use of clinics and use of alternative healers.

Cross-sectional surveys are designed to take a “snapshot” of a population. They provide the investigator with a view of a population in a given space and time. Cross-sectional surveys have been carried out by health care organizations to get reliable data in an efficient manner. In the United States the

National Health And Nutrition Experimental Survey (NHANES) and the Hispanic Health And Nutrition Experimental Survey (HHANES) are used to collect health care information on a variety of health care issues facing the general US population (NHANES) and the US Hispanic population (HHANES). From this data, suggestions have been made to improve health care for these populations.

a. Questionnaires and environmental/conservation issues

Questionnaires have also been used to gather information on a variety of environmental topics including ecotourism (Tershy, Bourillón, Metzler, et al., 1999), knowledge and attitudes about population growth and their effects on the environment (Holl, Daily, Daily, et al., 1999), and local villagers' attitudes about conservation (Gillingham & Lee, 1999). A 35-item multiple choice and short answer survey was developed to gather information from ecotourism companies, schools, and individuals about conservation and costs and benefits of ecotourism in a wildlife refuge in northwestern Mexico. The results indicated that ecotourism agencies and the local people should communicate with each other in order that they may best address conservation issues such as maintaining a pristine wilderness while supporting an active ecotourism trade. The questionnaire results also revealed information about the number of Mexican nationals employed by the local ecotourism industry and factors that make a Mexican citizen employable, activities attractive to ecotourists, facilities that would increase the quality of ecotourism, and factors that would decrease the attraction for ecotourism in that area (Tershy, Bourillón, Metzler, et al., 1999).

A survey was carried out with university students in the U.S. and Costa Rica in order to help shed light about student's attitudes of population growth and degradation of the environment, their interrelationship, and how these attitudes influence their personal lives. The questionnaire utilized 59 questions designed to evaluate either the student's knowledge and opinions about the environment. The results revealed that students, in general, should be taught more about the interrelationship between environmental problems and consumption. Also, their responsibilities in environmental issues should be stressed by educators and teaching about environmental issues should begin at the grade school level in order to make the most impact on environmental awareness (Holl, Daily, Daily, et al., 1999).

Local villagers living near the Selous Game Reserve in Tanzania were surveyed to measure their attitudes about how the allocation of wildlife related benefits has influenced their perceptions of conservation. The questionnaire included both open- and closed-ended questions that asked villagers about their background (household size and composition and socio-economic status) and their perceptions of the wildlife management projects related to the Selous Game Reserve. The results determined that there is widespread support of wildlife management activities at the national level but only about half of the respondents believed that wildlife management was benefiting them at the local level. It was also suggested that dialogue between all groups involved in conservation would be a better way to address conservation issues (Gillingham & Lee, 1999).

A variety of survey research methods can be incorporated into one study to obtain information from a population. Nepal and Weber (1995) set out to understand the complex issues of local peoples' attitudes, perceptions and tendencies toward wildlife conservation of villages who live near the Chitwan National Park Reserve in Nepal. They carried out a household survey of 200 households in 46 villages. They asked about household activities, education & employment status, resource needs, degrees of dependency on the National Park, and conservation attitudes. Informal interviews were also carried out with park professionals, village headmen, school teachers, local government officials, youth leaders, and politicians. Group discussions were also held at the village level. The survey results revealed that although there were varying levels of discontent with the park, most respondents displayed a positive attitude about the park. There was, however, discontent over the park's policy of protection which many villagers felt limited their access to the natural resources they needed. It was finally decided to form a committee that would represent the needs of the villages.

These studies demonstrate that information collected from people on their thoughts, perceptions, and behaviors can be used to initiate or streamline communication about conservation issues between people with differing points of view.

b. Questionnaires and ethnobotany

The quantitative ethnobotanical studies discussed in Chapter 1 were geared toward quantifying the value of tropical forests in order to advocate

for their conservation. Recently, other types of quantitative ethnobotanical studies have emerged. These studies use survey techniques that collect information in a consistent manner so it could be statistically analyzed intra- and inter-culturally.

A study which addresses both ethnobotanical and sociological issues was carried out by Farooquee and Saxena (1996) who wanted to get an idea of the socio-economic significance of medicinal herbs for the Bhotiya tribe in Uttar Pradesh, India. Household surveys were carried out in 20 villages. Information on income from agricultural produce, wool products, livestock and medicinal herbs was collected. The herbs represent the 14 most economically important species which the Bhotiya exploit for income. Interviews were also conducted of individuals who represented a cross-section of the communities. In addition, group discussions were held in the surrounding villages. It was found that factors such as a recent increase in population growth and change in diet (purchasing rice and wheat instead of using homegrown staples) were affecting collection of herbs. Also, increased monetary incentives for private companies to collect these herbs was putting pressure on the nearby wild population traditionally used by the Bhotiya. When officials declared the forest a sanctuary and prohibited further collection of herbs without permits, private companies took over collection of herbs so that extraction by these private companies overexploited these 14 species. This has caused the Bhotiya to lose income from the inability to gather and sell herbs. The Bhotiya felt that a decrease in herb collection was causing their people to lose an interest in these herbs. They

were afraid that this would, in turn, cause a loss of medicinal plant knowledge. Due to the dissemination of the results of this survey, the Bhotiya are now talking with each other and the herb collecting companies about the possibility of cultivating these herbs. They hope this will preserve not only the herbs but the knowledge of herbal uses.

Johns, Kokwaro, and Kimanani (1990) felt that ethnobotanical surveys of useful medicinal plants were oftentimes inconsistent in the method of information collection from informants. Uneven spatial distributions of plant resources and the prevalence of certain diseases in specific areas, compared to other areas from where the information is collected, introduced significant bias to ethnobotanical interviews. Therefore, they wanted to establish a method of data collection that would minimize the effects of these variables. Their study group was made up of Luo informants from the Siaya District of Kenya, Africa. They interviewed 45 herbalists about medicinal plant use. Interviews were open-ended and informants were asked to tell what remedies they used and how they used them (similar to the "inventory/interview" technique used by Boom (1987)). The interviewers also walked with informants through the forest and discussed plant uses as the informants identified the plants. Interviews were conducted by Luo students and staff of the University of Nairobi. The interview data revealed 1129 remedies from 330 species of plants. Eight diseases categories emerged: gastrointestinal, dermatological, *chira* (thinning disease), respiratory, oral problems, sore throat, toothache, and eye problems. Consensus for a use was established when 3 or more people independently reported the same use for the

same plant. This left 66 confirmed remedies. A log-linear model was used to interpret the data. Of significant interest to the investigators was the interaction component, which is the potential for a plant to be used as a cure for a disease. The higher the interaction value, the stronger the correlation was between the plant and the disease for which it was reported to treat. Ten plants were highly correlated in their treatment of gastrointestinal, dermatological (wound), spirit and respiratory diseases.

A similar attempt at quantifying ethnobotanical data was carried out by Varghese, Jain, and Bose (1993). They interviewed 14 “medicine men” and seven trained nurses on useful medicinal plants used by the Kharias tribe of Central India. They wanted to verify the authenticity of reported uses (from a previous study) and establish a credibility rating for each reported remedy. They asked about occurrence of plant, geographic location of the plant, respondents age, sex, and education, status (medicine man, nurse, doctor), forest type where the plant is found and availability in nature and at the market (e.g., common, frequent, occasional, rare). They asked about a disease the plant is used to treat, part used, mode of administration, and dosage. Using this data they applied a log-linear model similar to that used Johns, Kokwaro, and Kimanani (1990), to calculate the interaction value for plants and three most common diseases. Gastroenteritis, joint disease, and malaria were treated by 10, 10, and 6 plants, respectively, that had the highest interaction rates for the three diseases.

Although cross-sectional questionnaires are not widely used for ethnobotanical studies, they are occasionally used to obtain specific plant use information. A cross-sectional survey was carried out to determine patterns and frequency of chewing stick use for dental hygiene in Ghana (Adu-Tutu, Afful, Asante-Appiah, et al., 1979). The survey used in this study asked basic demographic information (age, sex, ethnic background, region, size of town, education, job), type/species of stick chewed and reason for preference, other species used for chewing, method of procurement, chewing stick used in childhood, and species used as medicines. The survey revealed that although many species of chew stick are used, only a few are important enough to be used on a frequent basis. Also, the kind of species used depended on age, sex and ethnic group. It was also speculated from this survey that use of chewing sticks may help prevent tooth decay (Adu-Tutu, Afful, Asante-Appiah, et al., 1979).

Other quantitative approaches have been reported for collecting and analyzing ethnobotanical information. The consensus approach is used to select viable plants by counting the number of times that plant is reported for treating a specific illness. The more times a plant is reported as a treatment for a specific illness, the more likely it will be veritable as a treatment for that illness (Trotter & Logan, 1986, p. 95). Another approach is to apply a Fidelity Ratio which is a "ratio between the number of informants who independently suggest the use of a species for the same major purpose and the total number of

informants who mentioned the plant for any use” (Friedman, Yaniv, Dafni, et al., 1986).

The closest example of the approach I used to collect quantitative ethnobotanical data is that presented by Phillips and Gentry (1993) who studied the useful plants of Tambopata, Peru. They interviewed 29 men, women, youths, and children using the “inventory/informed” technique. They recorded 1885 independent events, the number of times a respondent reports a use for a species. The events were summarized into 116 uses. They established a use value for each species for each informant. An “overall use value” for each species was then calculated as the ratio of the sum of use values of each species for each informant and the number of informants interviewed for that species. The benefit of this type of data analysis is that “the method of assigning importance is explicit and relatively independent of the researcher so that the results are potentially reproducible by different researchers,” an important requirement for the scientific method. It also permits statistical analysis to test the null hypothesis. They apply the species’ use value for making comparisons of species to find out if the species are equally useful among the respondents. This analysis can also be extended to make comparisons in uses between plant families.

Phillips and Gentry (1993) demonstrated that this kind of quantitative use value from ethnobotanical data can help answer questions relating to the plant-people relationship in a formal, statistical hypothesis-testing manner. Johns, Kokwaro and Kimanani (1990) stressed the need for using

quantitative survey methods in ethnobotanical research in order to better understand the interrelationship between culture and environment in a more concise manner. Phillips and Gentry (1993) suggested using the results to answer questions about species and forest conservation while Johns, Kokwaro and Kimanani (1990) suggested that quantifiable data can help predict the rationale for using a specific plant for a specific ailment, which can then be verified in the laboratory. A combination of these two approaches led me to establish the methodology used for this dissertation.

B. Summary

Because I had to collect information efficiently and in a standardized manner from the Winikina Warao, I developed and administered a cross-sectional survey of Winikina Warao plant use knowledge, something that had not been attempted with the Winikina Warao in the past. I wanted to find which of several plants, with wide variety of known uses, were going to be reported as useful for treating non-venomous laceration wounds. Of those plants reported, I wanted to establish a method of ranking them in order of wound healing importance in order to be able to select the plant reported most often for that use. That plant was to be chosen for bioanalysis.

My personal experience with the Winikina Warao gave me confidence that they would be able to participate in a cross-sectional survey. The Winikina Warao are an intelligent and dynamic people. They continue to

survive in this ecologically hostile environment and they are eager to share their knowledge as well as learn new customs.

Chapter 4.

Questionnaire Design

A. Format

A cross-section questionnaire was used to measure which of 18 pre-selected plants the Winikina Warao of two villages report for treating non-venomous wounds. Wounds caused by machetes or accidents that cause the skin to be severed are considered non-venomous laceration wounds. The respondents were not required to answer specifically "to treat non-venomous laceration wounds" when a plant was reported as a treatment for wounds. If a plant was reported as a treatment for wounds, the respondent was asked to describe the wound, how the plant was prepared, and how it was used to treat the wound.

The questionnaire used for this study was made up of 26 questions with sub-questions for several of the main questions (see Appendix E for a complete copy of the questionnaire in Spanish). An outline of the questionnaire is listed below:

- I. Basic Demography
 - A. Self-identity (Warao or non-Warao)
 - B. Birthplace
 - C. Time living in village under study and other villages
 - D. Number of children

- II. Plant Use Knowledge
 - A. Knowledge of 18 plants.
 - B. Plant part use knowledge (leaf, fruit, flower, bark, root, other, and apical meristem) of each of the 18 plants.
- III. Traditional Healers Use
 - A. ***Wisiratu***
 - B. ***Hoarotu***
 - C. ***Bahanarotu***
 - D. ***Yarokota Arotu*** (herbalist)
- IV. Clinical Service Use
 - A. Nabasanuka
 - B. Guayo
 - C. Barrancas
 - D. Tucupita
 - E. Caracas

The questionnaire was written in English, translated to Spanish, and then to the Warao language with the help of Benigno Rodriguez, a Warao who is a teacher in the village of Nabasanuka. He speaks both Spanish and Warao fluently. A pre-test of three Winikina Warao was carried out to improve the syntax of the questionnaire for smoother flow and to make any adjustments in presentation, as necessary. Those selected for the pre-test were not re-interviewed.

a. Basic demographic questions

The initial five questions of the questionnaire were used to gather basic demographic data from the respondent. They also helped the respondent

become familiar with the questionnaire technique used to ask questions, as well as help the respondents feel at ease.

Even though I had traveled to the Winikina region for my preliminary field work on several occasions and was familiar with the Winikina Warao of the villages of Morichitos and España, the interview style needed to carry out a questionnaire in a consistent manner could make the respondent feel intimidated. The interviewer must maintain a somewhat indifferent facial expression when asking the questions. Also, only the respondent, interpreter and interviewer were allowed to be present during the questionnaire session. This is unusual for the Warao who have family and extended family members take an active role in each others lives. So I asked the headman of each village, who also served as interpreters, ask the villagers to stay clear of the house during the interviews but that they could come and ask me anything, and resume their normal activities in the house, when I completed an interview. Besides acquainting the respondents with the questionnaire format, these initial questions also helped demonstrate that I was genuinely interested in their personal life history, an important requirement for establishing a bond of trust with the Winikina Warao. Trust is instrumental in getting the best information from any respondent.

The first question asked the respondent to identify him/herself either as a Warao or *hotarao*. The Warao, as stated earlier, do not consider themselves as one large homogenous group. They identify another Warao by physical appearance as well as language affinity. Although a Warao may

recognize another person as Warao, the concept of a "Warao nation" does not exist (Urbina & Heinen, 1982). However, a non-Warao (*hotarao*) is one who does not speak Warao and does not have the physical appearance of a Warao.

The second question asked the respondent to state how long he/she has lived in the village of current residence (the village where the questionnaire is taking place—Morichitos or España). The respondent is asked if he/she has resided in that village all his/her life. If the respondent had lived or was born elsewhere, this was noted and a brief history of other residences was recorded. Respondents were also asked the number of children they had irregardless of whether the respondent was male or female. Although the respondents were not asked their gender, it was noted on their response sheet.

b. Plant use knowledge questions

Carrying out a questionnaire about all plants used by the Winikina Warao would have proven daunting. I did not have the time or resources to carry out such a large questionnaire and the respondents would have lost interest. Therefore, I decided to focus on 18 plants with known ethnobotanical uses by the Winikina Warao. Because I wanted to find out about the use of non-venomous wound healing plants, within this group of 18 plants I interspersed seven plants known from the Winikina Warao for treating non-venomous wounds. These seven wound healing plants were selected from my own field work and from Werner Wilbert's *Warao Herbal Medicine* (1986). Twelve (12) of the plants were trees, two (2) were herbaceous and four (4) were palms.

Early in the study I thought about bringing live or dried samples of the plants to each respondent as part of the questionnaire. However, the bark, root, and apical meristem (in the case of the four palms) plant parts were a part of the questionnaire so I would have needed to show the respondent the entire plant (one cannot carry around an entire *ohidu* palm!). I also thought about marking the plants in the forest and taking each respondent to the plant. However, finding all 18 plants within a short distance of the village or with flowers and/or fruits was not going to be possible for all 18 plants. Because of these limitations, I decided to select plants that were well known by the Winikina Warao and ask them if they knew these plants.

The 18 plants chosen for the questionnaire (Table 4.1) were based on the following criteria: (i) well known ethnobotanical use by the Winikina Warao (food, medicine, construction, etc.), (ii) the plants had one common name that was not used for any other plant, (iii) the plant was not easily confused with other plants, and, for seven of the plants, (iv) reported as a remedy for treating non-venomous wounds by the Winikina Warao. The plants were selected from a review of Warao articles that reported some plant use with at least a common name for the plant (Schad, 1953, 1954; J. Wilbert, 1963, 1964, 1967, 1970, 1972, 1980b; Torres, 1966; W. Wilbert, 1986; Heinen, 1988) and my own field work and plant collections.

Table 4.1. Plants used for the questionnaire listed in order as they appear on the questionnaire.

<u>Common Name</u>	<u>Scientific Name</u>
Mango	<i>Mangifera indica</i> L.
Usiru*	<i>Spondias mombin</i> L.
Hemuru	<i>Montrichardia aborescens</i> (L.) Schott
Idu	<i>Ceiba pentandra</i> Gaertn.
Homoarao	<i>Pachira aquatica</i> Aubl.
Sibu	<i>Protium guianense</i> March.
Ohoru*	<i>Symphonia globulifera</i> L.f.
Korokororo	<i>Hernandia sonora</i> L.
Nasinaba	<i>Ocotea</i> sp. Aubl.
Bihibihidu*	<i>Pentaclethra macroloba</i> Kuntze
Iburu	<i>Pterocarpus officinalis</i> Jacq.
Kuahineru	<i>Pterocarpus</i> sp. Jacq.
Samariya*	<i>Cedrela fissilis</i> Vell.
Anare*†	<i>Euterpe oleracea</i> Mart.
Winamoru†	<i>Euterpe precatoria</i> Mart.
Yaha†	<i>Manicaria saccifera</i> Gaertn.
Ohidu*†	<i>Mauritia flexuosa</i> L.f.
Murusi*	<i>Renealmia alpinia</i> (Rottb.) Maas.

* Plants reported for treating non-venomous wounds.

† Palms.

The basic structure of the plant use knowledge questions (Figure 4.1) begins first by asking the respondent if he/she knows the plant. Even though some of the plants had a Spanish common name, the Warao name was used to refer to the plant. If the plant was known, then the respondent was asked a subset of questions asking about uses for the specific plant part (leaf, fruit, flower, bark, and roots). The plant parts, leaf, fruit, flower, bark, and roots,

are basic plant components which are used most often by the Warao. They are the most common parts reported when asked about plant use according to my fieldwork with the Winikina Warao. Also, they are the most salient parts of a plant. If there were other features of the plant which should be known for their uses, the final sub-question asked if any “other” use was associated with the plant. An “other” option was provided for a use which the respondent either a) does not feel fits into one of the plant part categories provided, or b) the respondent remembers a use at a later time during the course of the questioning. If the respondent did not know the plant, the entire subset of questions for that plant was skipped and followed by the next plant.

Figure 4.1. Basic plant use question structure (English version).

6.	Do you know [<i>name of plant</i>]?	YES or NO	<i>(If NO, pass to Q. 7)</i>
6a.	Is the leaf used?	YES or NO	
	6a.i. What is the leaf used for?		
6b.	Is the fruit used?	YES or NO	
	6b.i. What is the fruit used for?		
6c.	Is the flower used?	YES or NO	
	6c.i. What is the flower used for?		
6d.	Is the bark used?	YES or NO	
	6d.i. What is the bark used for?		
6e.	Are the roots used?	YES or NO	
	6e.i. What are the roots used for?		
6f.	Does [<i>name of plant</i>] have any other use?	YES or NO	
	6f.i. What other uses does the [<i>name of plant</i>] have?		

For the four palms listed in the questionnaire (*anare*, *winamoru*, *yaha*, and *ohidu*), an additional question was asked about apical meristem (palm heart) use (Figure 4.2).

Figure 4.2. Basic plant use question for palm apical meristem (English version).

18. Do you know the **anare**? YES or NO *(If NO, pass to Q. 19)*

18g. Is the apical meristem used? YES or NO

18.a.i. What is the apical meristem used for?

c. Wound healing plants

Classification of wounds by the Winikina Warao fall into two categories: non-venomous and venomous. Non-venomous wounds are lacerations to the skin. Venomous wounds are caused by the bite of an animal, such as a scorpion or snake, who releases a poisonous venom into the victim. The sting of a stingray is not considered venomous because no venom is released when the stinger pierces the skin.

Table 4.2 lists the seven non-venomous wound healing plants reported by the Winikina Warao, including part used for treatment and preparation of the plant material.

Table 4.2. Plants known to be used by the Winikina Warao as treatments for non-venomous wounds (based on personal field notes and W. Wilbert (1986)) listed in the same order as presented in the questionnaire.

Common Name (Species Name)	Part Used	Preparation
Usiru (<i>Spondias mombin</i>)	Bark oil	Scrape inner surface of bark until a small ball of oily shavings is accumulated. Place oil over wound.
Ohoru (<i>Symphonia globulifera</i>)	Trunk	Place one end of log over fire and let the mustard-yellow sap drip into vessel. Place latex directly on wound.
	Bark	Scrape bark and place shavings into a vessel containing one-half liter of fluid from young <i>Manicaria saccifera</i> fruit (liquid endosperm) and soak for 10 minutes. Remove shavings and remaining pulp and fluid are employed for treatment.
	Bark Sap	Place yellow sap collected from bark cortex directly onto the wound. Allow to dry.
Bihibihidu (<i>Pentaclethra macroloba</i>)	Bark	Scrape inner surface of bark. Boil shavings in water for 30 minutes.
Samariya (<i>Cedrela fissilis</i>)	Bark	Place bark strips on fire located over patients hammock. Smoke reduces the pain as the wound caused by a stingray sting is placed directly over the smoke.
Anare (<i>Euterpe oleracea</i>)	Stem of sapling	The stem is placed over fire to liquefy the sap. Once heated, the stem is cut in the middle, folded over, and the watery sap collected in a vessel and used to wash the wound.
		Cut stem into small pieces and boil in water for 20 minutes to leach out sap. Wash wound.
Ohidu (<i>Mauritia flexuosa</i>)	Heart of palm	Grate palm heart into a liter of water. Knead the mixture into a white paste. Place over wound.
Murusi (<i>Renealmia alpinia</i>)	Leaves	Heat leaves over coals, crumple, and form into a compress.

d. Use of traditional healers

For the Winikina Warao illness can have one of two etiologies. It may be caused by a malevolent spirit sent by another shaman, usually from another village, that has entered the body. The other type of illness is caused by a fetid air that has entered the body. Either way, the patient is initially taken to the shaman (**wisiratu**, **hoarotu**, **bahanarotu**), usually a male, for diagnosis. If the illness is not caused by a malevolent spirit then it is caused by a fetid air that has entered the body. In this case, an herbalist (**yarokotu arotu**), usually a woman, is sought to treat the patient (W. Wilbert, 1986, 1987).

Increasingly due to outside influences on Warao youth, and because of reliance on health clinics for health care, the importance of the shaman in communicating and satisfying the gods to prevent illness among the Warao, is diminishing (J. Wilbert, 1983). In the village of Morichitos there is one **hoarotu** and in España there is one **wisiratu**, neither of which have an apprentice. The herbal remedies, on the other hand, can be prepared by many villagers although the women are usually the ones with more experience. It is the **yarokotu arotu** who is the master herbalist, one who has the most medicinal plant knowledge. Although the **yarokotu arotu** does not have as high a profile as the shaman, the villagers know to which woman they can turn to for the best medicinal plant remedy (W. Wilbert, 1986). The questions about traditional healer use were asked to find out to what extent traditional healers are sought by the respondents. They were also a good segue from the 18 plant questions.

e. Health care clinic use

If a patient in either Morichitos or España is not getting better despite the efforts of the spiritual healer and the *yarokotu arotu*, he/she may be taken to the nearest clinic, *Medicatura Herbig* in the mission village of **Nabasanuka**. It is about 2-3 hours by canoe from Morichitos and 3-4 hours from España. Another *Medicatura* further south in the Delta is in the village of Guayo. In some cases, the patient may be taken to this clinic. However, it is not favored because it is much further away than **Nabasanuka** and offers almost the same services as the clinic in **Nabasanuka**. If an illness is grave and a physician or paramedic in either of the two village clinics recommends it, the patient can be sent to a hospital in Tucupita, the capital of the state of Delta Amacuro. Also, because many of the Winikina Warao travel with their families to the port town of Barrancas for work, they may use health care services in Barrancas from time to time. Winikina Warao who venture as far as Caracas, the capital of Venezuela, to sell their crafts and/or panhandle, are likely to visit a medical clinic in Caracas should they become ill while in the capital. Thus, the health care clinic use questions were used to gather information about use of non-traditional health care resources. With this last set of questions completed, the respondent was thanked and the survey terminated.

B. Village Selection

The two villages chosen for this study were Morichitos and España. Both are located along the Winikina River about two kilometers from each other

with España further down river. These two villages were chosen because the Warao who live here continue to maintain many of the traditions associated with the pre-agricultural Winikina Warao. For example, their houses are almost exclusively made of thatch from the leaves of **yaha** palm (*Manicaria saccifera* Gaertn.). Houses of the Warao which have more contact with *criollos* in the villages and towns along the Delta periphery are more than likely made of flat sawnboards or corrugated tin. The boardwalk which runs the length of the Winikina villages along the river's edge is made mostly from the trunks of the **anare** palm (*Euterpe oleracea* Mart.). Villages and towns along the Delta periphery usually have boardwalks made almost entirely of cement or sawnboards.

More importantly, the Winikina Warao of the two villages continue to use plants for a variety of purposes. Fish and *ocumo* (*Colocasia esculenta* (L.) Schott) are the primary source of food. Very few processed foods have made it into this region although flour purchased in 1 kg bags, used to make bread, has become an important staple. They use the fruits of **murusi** (*Renealmia alpinia* (Rottb.) Maas.) to make dye for their baskets and hammocks. They construct large baskets made from a variety of plant material. Hammocks used by the Winikina Warao or sold in the market place are made from **ohidu** palm (*Mauritia flexuosa* L.f.).

These features alone are not the only indicators of a traditional Warao society. A more important indicator is whether the Warao celebrate the traditional sacred festival of the **Nahanamu** and **Habisanuka**. In Morichitos and

España, these festivals continue to be celebrated although much of the religious meaning behind the festival is not as relevant as it was 30-40 years ago since the introduction of **ocumo** and flour.

In the two study villages there are still shaman living there. The village of España has one resident **wisiratu** shaman, one of a handful that still exist in the Winikina region. The village of Morichitos has a **hoarotu** shaman. These shaman are almost non-existent in villages located along the periphery of the Delta. Finally, both villages do not have any *criollos* living among them.

C. Respondent Selection

The headman of each of the two villages, Morichitos and España, was contacted during the preliminary fieldwork for this project. We established rapport and a friendship developed that continues to this day. The project goals and the survey format were explained to the headman of each village. A meeting of the villagers of each village was then called and the project explained to those who attended. Approval was sought and obtained from the village (Appendix D).

Participants were recruited by going from house to house with the headman and writing the names of each person who was at least 15 years old and interested in participating. The age of 15 was chosen as the minimal participatory age because this is when Warao adolescents have reached puberty and are entering adulthood. It is also at this age that they can unite with a partner and establish a family. The names of the volunteers were recorded in a notebook and assigned numbers which were then written on small pieces of

paper. The population of Morichitos at the time of this survey was 66 and that of España was 90. The total population size was 156. The total sample size of 40 represents 26% of the population, more than one-quarter of the total population.

The papers were folded, collected in a small basket, and the basket shaken. A volunteer Winikina Warao pulled 20 numbers out of the basket. The 20 randomly selected respondents were notified of their selection. If a chosen respondent was not in the village at the time of the study and was not going to return during the duration of the survey, or if a respondent decided not to participate, then another number was randomly selected in the same manner as before. This was done until 20 questionnaires were completed. If a participant decided to end the questionnaire before all questions were read (which happened once in each village), a new respondent was selected.

D. Survey Interviews

The first set of 20 interviews took place in the village of Morichitos from 19-24 March, 1999. The second set of 20 interviews took place in the village of España from April 9-12, 1999. The interviews were conducted in either Spanish or Warao, based on the respondent's choice.

I learned to administer the questionnaire in the Warao language but needed help interpreting responses if they became long and detailed. An interpreter, the headman of each of the two villages, was used for the surveys. The interpreters role was only to interpret the respondents' replies. The interpreters were paid for their services.

Once the respondent, interpreter and myself sat down to begin the survey (Figure 4.3), the procedure for carrying out the questionnaire was

explained to the respondent. The respondent was advised that he/she could stop the survey at any time and begin at a later time if he/she chose. The respondent was also told



Figure 4.3. Lorenzo Moreno, Alfredo Gomez-Beloz, and a respondent being interviewed in the village of España.

that he/she could terminate the survey at any time without any negative consequences. They were advised that they were under no pressure to complete the survey. The respondent was also advised to report all uses for each plant, not only the medicinal uses of the plants. I gave an example of a plant such as *anare* and explained that it could have many uses. I also reiterated this statement at the start of some of the questions as a reminder to the respondent.

The entire questionnaire took from 0.5-2.0 hours to administer, depending on (i) how many plants the respondent knew, (ii) how many uses were known for the plant, (iii) the complexity of use answers, and (iv) the amount of interpreting required. When each questionnaire was completed, the respondent was thanked for his/her participation. Based on a meeting with all villagers of each village prior to the start of the interviews, it was decided that each

respondent who participated was awarded with a complementary gift that included either a 3 X 3 m piece of dress cloth for the women or 30 m of fishing line and five large fish hooks for the men.

Chapter 5.

Questionnaire Results

A. Basic Demographics

All the data for the questionnaire was recorded in a spiral notebook and later analyzed using the SPSS Statistical software package. Paired sample t-tests were carried out using 95% confidence intervals and considered significant at $p < 0.05$ and highly significant at $p < 0.01$.

a. Self identity and place of origin

All of the respondents in both villages were Warao. In the village of Morichitos, 8 (40%) respondents were born in that village and 11 (55%) were born somewhere else but in the same region. Those that were born outside Morichitos were born in *Barranquilla*, *Caño Hakanoko*, *España*, *Guayo*, *Isla Pequeña*, *La Isla*, *Nabasanuka* (2 respondents), *morichal* on *Isla Atoibo*, *morichal* on *Isla Mojoina*, and a logging camp upriver from *Morichitos* along the Winikina river. One respondent did not recall where she was born. Of those who were born in Morichitos, five respondents had lived in other areas of the Delta such as *Barrancas*, *España*, *Barranquilla*, *Isla Mariusa*, *Nabasanuka*, *Asseradero*, and the indigenous communal house called ***Yakeriene***, in Tucupita. Three respondents had lived in Morichitos all their lives.

In the village of *España*, 13 (65%) were born in that village, whereas only 7 (35%) were born outside the village. Those that were born

outside España were born in *Arawabisi*, *Asserradero*, *Kuarehoro*, *Kuberuna*, *morichal* in *Isla Atoibo* (2), and a *morichal* on the lower Winikina river, Of those born in España, only two (15%) had ever lived outside the village of España in the villages of *Hotahana* and *Barranquilla* or the geographic regions such as *Caño Arawabisi*, *Caño Soberojo*, the *morichal*, *Isla Atoibo* and *Isla Mariusa*.

b. Length of residence

The shortest time for a respondent living in Morichitos was three years and the longest was 70 years with an average of 23.4 years. In España, the shortest time was one year and the longest was 59 years. The average time living in España for the respondents of this village was 25.8 years. A paired sample t-test comparing time living in each village showed no statistically significant difference between the amount of time respondents had lived in their respective villages.

c. Children

Four respondents in Morichitos had no children while the remaining 16 reported from one to 14 children. In España, five respondents reported no children while the remaining respondents had from one to eight children. The average number of children for a Morichitos respondent was 4 and in España the respondents had an average of 3 children. There was no significant difference in number of children between the respondents of the two villages.

d. Age distribution

For the Morichitos respondents, the youngest and oldest ages were 15 years and 70 years, respectively. The average age was 30.2 years. The youngest and oldest respondents for the España respondents were 16 years and 59 years, respectively. A paired sample t-test for age of the respondents showed no significant difference in age between the respondents of the two villages.

e. Gender

In Morichitos, six respondents were male and 14 were female. In España, nine respondents were male and 11 were female. There was no significant difference in gender between the respondents of the two villages.

f. Traditional healer use

Respondents were asked whether they utilized, at any time, any of four traditional Warao healers. Table 5.1 lists the results for the Morichitos and España respondents.

Table 5.1. Reported use of four traditional Warao healers by the Morichitos respondents.

	Reported "Yes"	Reported "No"
<i>Wisiratu</i>	12 (60%)	8 (40%)
<i>Hoarotu</i>	15 (75%)	5 (40%)
<i>Bahanarotu</i>	13 (65%)	7 (35%)
<i>Yarokotu arotu</i>	13 (65%)	7 (35%)
mean	13.3 (66%)	6.7 (34%)

Reported use of four traditional Warao healers by the España respondents.

	Reported "Yes"	Reported "No"
<i>Wisiratu</i>	9 (45%)	11 (53%)
<i>Hoarotu</i>	11 (55%)	9 (45%)
<i>Bahanarotu</i>	10 (50%)	10 (50%)
<i>Yarokotu arotu</i>	9 (45%)	11 (55%)
mean	9.8 (49%)	10.3 (51%)

g. Health care clinic use

The respondents were asked if they used any non-Warao health care clinics. The Winikina Warao are located closer to the ***Nabasanuka*** clinic (*Medicatura Herbig*) than the one at Guayo. The port town of Barrancas, Tucupita, and Caracas, are locations where there is only a hospital that is used by the Warao. Tables 5.2 and 5.3 list the responses for the use of health care clinics.

Table 5.2. Reported use of health care clinics by the Morichitos respondents.

	Reported "Yes"	Reported "No"
Nabasanuka	15 (75%)	5 (25%)
Guayo	2 (10%)	18 (90%)
Barrancas	8 (40%)	12 (60%)
Tucupita	1 (5%)	19 (95%)
Caracas*	6 (30%)	11 (55%)*

*The option of "Caracas" as a health care choice was added after the third respondent.

Table 5.3. Reported use of health care clinics by the España respondents.

	Reported "Yes"	Reported "No"
Nabasanuka	10 (50%)	10 (50%)
Guayo	2 (20%)	18 (80%)
Barrancas	5 (25%)	15 (75%)
Tucupita	2 (10%)	18 (90%)
Caracas	2 (10%)	18 (90%)

B. Plant Use Questions

a. Reported knowledge for each plant

The first question asked in the plant use knowledge section of the questionnaire was whether a respondent knew the mentioned plant (see Figure 4.1). Morichitos respondents reported knowing an average of 16 plants each and España respondents reported knowing an average of 17 plants each.

There was no significant difference in number of plants known between the two villages.

Each Morichitos respondent reported an average of 24 total uses for all 18 plants. Each España respondent reported an average of 23 total uses for all 18 plants. When comparing total number of responses for each village, there was no statistically significant difference in total individual reported use between the two villages.

A comparison was made between the respondents of the two villages to measure if there was any difference in total number of reported uses for each of the 18 plants (Table 5.4). For these comparisons, the values are based only on a count of number of reported uses by the respondents. This does not reflect a comparison in specific uses (to treat fever, to make a canoe, etc.) reported by the respondent for each plant.

Table 5.4. A comparison between the two villages to measure differences in total reported uses for each plant.

Plant	Mean Number of use responses per respondent for each plant		Significance
	Morichitos	España	
<i>Mango</i>	2.65	1.85	**
<i>Usiru</i>	1.60	1.95	ns
<i>Hemuru</i>	0.90	0.80	ns
<i>Idu</i>	0.25	0.55	ns
<i>Homoarao</i>	0.90	0.70	ns
<i>Sibu</i>	1.10	1.10	ns
<i>Ohoru</i>	0.55	0.62	ns
<i>Korokororo</i>	0.95	1.00	ns
<i>Nasinaba</i>	1.25	1.65	ns
<i>Bihibihidu</i>	0.45	0.10	*
<i>Iburu</i>	0.75	0.75	ns
<i>Kuahineru</i>	0.20	0.25	ns
<i>Samariya</i>	0.65	0.75	ns
<i>Anare</i>	2.35	2.25	ns
<i>Winamoru</i>	1.15	1.15	ns
<i>Yaha</i>	3.00	2.40	ns
<i>Ohidu</i>	4.10	3.65	ns
<i>Murusi</i>	1.60	1.70	ns

Significance: * $p < 0.05$; ** $p < 0.01$, ns = not significant

The only significant difference in reported uses was for *mango* and *bihibihidu*. *Idu* has a significance of $p=0.055$ which makes it borderline significant. *Sibu*, *iburu*, and *winamoru* had an equal number of specific use reports by the respondents of both villages.

b. Specific uses for each plant

A total of 488 uses were reported by the village of Morichitos respondents for the 18 plants. España respondents reported a total of 465 uses for the 18 plants. There were a total of 80 different specific uses reported by the two villages which were broken down into 12 use categories. Table 5.5 lists the specific reported uses and their corresponding category.

Table 5.5. Specific Reported Use and corresponding use category.

<u>Specific Reported Use</u>	<u>Use Category</u>
all use	other
bad cold	medicinal
bathe child	medicinal
bathe mother	medicinal
Bleach	other
Boardwalk.....	construction
bow (for hunting).....	construction
buoy (for fishing).....	construction
calm pain	medicinal
Canoe.....	construction
Canoe to bury person	religious
Catarrh	medicinal
Chair.....	construction
Childbirth	medicinal
Cold	medicinal
Cough.....	medicinal
Diarrhea.....	medicinal
Diarrhea and grippe.....	medicinal
Diarrhea and vomiting	medicinal
Diarrhea with blood.....	medicinal
Diarrhea with catarrh	medicinal
Diarrhea with green stool.....	medicinal
Diarrhea with intestinal worms.....	medicinal
dye for string, folk basket, hammock.....	dye

Table 5.5. Specific Reported Use and corresponding use category.

<u>Specific Reported Use</u>	<u>Use Category</u>
eat (including juice use)	food
Feeling bad	medicinal
Fever	medicinal
fever and catarrh	medicinal
fever and diarrhea	medicinal
fever and grippe	medicinal
fever and headache	medicinal
fever, diarrhea, all illness	medicinal
fever, diarrhea, grippe	medicinal
fever, headache, cough	medicinal
Firewood	firewood
fish bait	piscicide
Fishing	fishing
flat sawn boards	construction
folk basket	commercial
fruit, to give	ontogenesis
give to small baby (<1 yr.)	medicinal
Grippe	medicinal
Grippe, catarrh, and fever	medicinal
Hammock	construction, commercial
Headache	medicinal
Honey (as food and indicator of honey)	food
House (roof, wall)	construction
House floor	construction
House in morichal (roof, wall, floor)	construction
Injury	medicinal
Intestinal worms	medicinal
lining of basket	folk use
Maggots from bark (for eating)	food
Makes flower	ontogenesis
Menses, excessive	medicinal
Mouth sore	medicinal
Necklace-incl. for child	medico-religious
Newborn	medicinal

Table 5.5. Specific Reported Use and corresponding use category.

<u>Specific Reported Use</u>	<u>Use Category</u>
Oar	construction
Pain	medicinal
Prevent illness	medicinal
Protection against <i>hebu</i> spirit	medico-religious
Quench thirst	food
Scabies	medicinal
Scabies wound	medicinal
sell for food	commercial
sick child	medicinal
Snake bite	medicinal
Stingray wound	medicinal
Table	construction
Toothache	medicinal
Toy	construction
toy canoe	construction
use to carry things	construction
Vomiting	medicinal
wasp bite	medicinal
Water	food
Wina	magico-religious
Wound	medicinal
Yuruma	food

The commercial, construction, dye, firewood, food, medicinal, and religious categories are based on those described from a variety of ethnobotanical studies (Aldunate, Armesto, Castro, et al., 1983; Prance, Balée, Boom, et al., 1987, 1995; Boom, 1987, 1990; Salick, 1992; Johnston & Colquhoun, 1996). The medico-religious category includes plants that are used to protect oneself from a spirit that might cause an illness. The magico-spiritual category is used for plants used for divination in religious ceremonies. A

piscicide plant is one that is used to poison fish directly in the water while the fishing category is for plants used as fish bait. The ontogenesis category includes plant parts that are reported to bring about another plant part (e.g., the flower creates the fruit). Folk artifacts are plants that are used to make folk products (baskets, hammocks, swings, etc.) either for personal use or for sale in Tucupita and other outside markets. The "other" category includes any use which does not fit into any of the 12 categories.

C. Plant Use Values

a. Reported Use (RU) value

Reported Use (RU) value is the total number of uses reported for each plant. Reported Use is also broken down for number of reported uses for each plant part for a specific plant ($RU_{[plant\ part]}$). The RU values for each of the 18 plants used for the questionnaire are found in Tables 5.11 to 5.46. A sum of the total number of Reported Uses for a plant in a particular village is ΣRU . It is calculated from all the responses of the 20 respondents for each village for each plant. The ΣRU is similar to the use value of a species as reported by Phillips and Gentry (1993). There is a ratio of the number of uses reported in each event by an informant in relation to number of events for that species. In this dissertation, the number of events, "the process of asking one informant on one day about the uses they know for one species" (ibid.) is one (1) for this study since the respondents were interviewed only once. Referring to Table 5.11 as an

example, ΣRU for *mango* in the village of Morichitos is 53 (53 total reported uses from all 20 Morichitos respondents).

Because the questionnaire asked about uses for specific plant parts (leaf, fruit, flower, bark, root, apical meristem) and for any other use, the reported use is broken down for plant parts and is represented as $\Sigma RU_{[\text{plant part}]}$. The order of the plant parts is based on the order presented in the questionnaire. Again, using the *mango* data from Table 5.11, the $\Sigma RU_{[\text{plant part}]}$ results for the village of Morichitos are listed in Table 5.6.

Table 5.6. $\Sigma RU_{[\text{plant part}]}$ for *mango* (*Mangifera indica* L.) for the Morichitos respondents.

$\Sigma RU_{[\text{leaf}]}$	=	16
$\Sigma RU_{[\text{fruit}]}$	=	20
$\Sigma RU_{[\text{flower}]}$	=	2
$\Sigma RU_{[\text{bark}]}$	=	14
$\Sigma RU_{[\text{root}]}$	=	1
$\Sigma RU_{[\text{other}]}$	=	0
ΣRU		<u>53</u>

b. Plant Part Value (PPV)

The second value listed in the Use Value tables is the Plant Part Value (PPV). This is the ratio of reported uses for a plant part in relation to total reported uses for the plant (Figure 5.1). It provides a measurement of the importance of a plant part within a species.

Figure 5.1. Plant Part Value (PPV) Ratio.

$$\text{Plant Part Value (PPV)} = \frac{\sum RU_{[\text{plant part}]}}{\sum RU_{[\text{plant}]}}$$

Table 5.7 lists the Plant Part Values from the Morichitos respondent's *mango* data.

Table 5.7. Ranked Plant Part Values (PPV) for *mango* (*Mangifera indica* L.) for the Morichitos respondents.

$PPV_{[\text{mango, fruit}]}$	=	= 0.377
$PPV_{[\text{mango, leaf}]}$	=	= 0.302
$PPV_{[\text{mango, bark}]}$	=	= 0.264
$PPV_{[\text{mango, flower}]}$	=	= 0.038
$PPV_{[\text{mango, root}]}$	=	= 0.019
$PPV_{[\text{mango, other}]}$	=	= 0.000
$\sum PPV_{[\text{mango}]}$	=	= 1.000

The use importance of the plant parts in the case of *mango* for the Morichitos respondents, using the PPVs from Table 5.11, is:

fruit > leaf > bark > flower > root

The fruit is used more often than the leaf, bark, flower, or root.

c. Specific Reported Use and Specific Use (SU) value

The Specific Reported Use is the use as reported for each plant part by the respondent. It is one of the 80 specific uses listed in Table 5.5. The number of times a Specific Reported Use is reported for each plant part is the Specific Use value (SU). The sum of all specific uses for each plant part is $\sum SU$

and is equal to the $\Sigma RU_{[\text{plant part}]}$. The ΣSU for the leaf of *mango* as reported by the Morichitos respondents is listed below (Table 5.8).

Table 5.8. Ranked Specific Use (SU) values for Specific Reported Uses for leaf of *mango* (*Mangifera indica* L.) from Morichitos respondents.

$SU_{[\text{mango, leaf, injury}]}$	=	6
$SU_{[\text{mango, leaf, diarrhea}]}$	=	5
$SU_{[\text{mango, leaf, wound}]}$	=	2
$SU_{[\text{mango, leaf, headache}]}$	=	1
$SU_{[\text{mango, leaf, makes flower}]}$	=	1
$SU_{[\text{mango, leaf, bathe newborn}]}$	=	1
$\Sigma SU_{[\text{mango, leaf}]}$	=	<u>16</u>

The ΣSU for fruit, flower, bark, root and other can be calculated in the same manner as above.

d. Intraspecific Use Value (IUV)

The Intraspecific Use Value (IUV) (Figure 5.2) is the ratio of number of Specific Reported Use as reported for a plant part ($SU_{[\text{plant part}]}$) relative to all reported uses for the plant part ($\Sigma SU_{[\text{plant part}]}$).

Figure 5.2. Calculation of Intraspecific Use Value (IUV).

$$\text{Intraspecific Use Value (IUV)} = \frac{SU_{[\text{plant, plant part}]}}{\Sigma SU_{[\text{plant, plant part}]}}$$

Table 5.9 lists the IUV for leaf of *mango* reported by Morichitos respondents.

Table 5.9. Ranked Intraspecific Use Values and Σ IUV for the leaf of *mango* (*Mangifera indica* L.) from the Morichitos respondents.

IUV _[leaf, injury]	=	0.375
IUV _[leaf, diarrhea]	=	0.313
IUV _[leaf, wound]	=	0.125
IUV _[leaf, headache]	=	0.063
IUV _[leaf, makes flower]	=	0.063
IUV _[leaf, bathe newborn]	=	0.063
Σ IUV _[Morichitos, mango, leaf]	=	<u>1.000</u>

The IUV is calculated for plant parts of each plant. Intraspecific Use Values can only be used in relation to the plant for which they refer. They are not used to make overall use generalizations for the entire plant or in ranking of uses for all the plants. They can be used to rank specific reported use importance for a plant part of a specific plant. The ranking order of specific uses for the leaf of *mango* is:

injury > diarrhea > wound > headache > makes flower > bathe newborn

Thus, the highest IUV for the leaf of *mango* is for treating injuries, a medicinal category use.

e. Overall Use Value (OUV)

One of the goals of this project was to select the plant reported most often for treating non-venomous wounds. The Overall Use Value (OUV) was developed for this purpose. It is based on the Fidelity Level described by Friedman, Yaniv, Dafni, et al. (1986). The Fidelity Level is "the ratio between number of informants who independently suggested the use of a species for the

same major purpose and total number of informants who mentioned the plant for any use." It is not to be confused with the "overall use value" as described by Phillips and Gentry (1993) which is the ratio of use value of a species for each informant and the number of informants interviewed for that species. The Overall Use Value in this dissertation refers to the ratio of total specific uses for a plant part, $\Sigma SU_{[plant\ part]}$, relative to the total number of reported uses for the whole plant (ΣRU). The OUV can be derived by multiplying PPV and IUV (Figure 6.3).

Figure 5.3. Calculation of the Overall Use Value.

$$\begin{aligned}
 OUV_{[plant]} &= PPV \quad \times \quad IUV \\
 OUV_{[plant]} &= \frac{\Sigma RU_{[plant\ part]}}{\Sigma RU_{[plant]}} \times \frac{SU_{[plant\ part]}}{\Sigma RU_{[plant\ part]}} \\
 OUV_{[plant]} &= \frac{SU_{[plant\ part]}}{\Sigma RU_{[plant]}}
 \end{aligned}$$

$$*\Sigma RU_{[plant\ part]} = \Sigma SU_{[plant\ part]}$$

Table 5.10 lists the Overall Use Values for the *mango* example.

Table 5.10. Overall Use Values (OUV) for *mango* from the Morichitos respondents.

OUV _[leaf, injury]	=	0.113
OUV _[leaf, diarrhea]	=	0.094
OUV _[leaf, wound]	=	0.038
OUV _[leaf, headache]	=	0.019
OUV _[leaf, makes flower]	=	0.019
OUV _[leaf, bathe newborn]	=	0.019
OUV _[fruit, eat]	=	0.377
OUV _[flower, to give fruit]	=	0.037
OUV _[bark, injury]	=	0.094
OUV _[bark, wound]	=	0.094
OUV _[bark, diarrhea]	=	0.038
OUV _[bark, scabies wound]	=	0.019
OUV _[bark, bathe mother]	=	0.019
OUV _[root, toothache]	=	0.019
ΣOUV _[Morichitos, mango]	=	1.000

The OUV can be used to compare use importance for a group of plants by adding up the OUVs for a specific use. For example, to find the plants regarded most important as a treatment for injuries, the OUV for "injury" from all 18 plants is added together (Figure 5.4).

Figure 5.4. Calculation of Overall Use Value for “injury” use for *mango* (*Mangifera indica* L.) from the Morichitos respondents.

OUV_[specific use]	=	The overall use values reported for the specific use “injury”
OUV_[injury]	=	OUV_[mango, leaf, injury] + OUV_[mango, bark, injury]
	=	0.113 + 0.094
OUV_[injury]	=	0.207

The OUV for “injury” for *mango* from the Morichitos respondents is 0.207. the OUV for “injury” from España respondents, the **OUV_[injury]** is 0.189 and is reported from *mango*. Thus, the $\Sigma \text{OUV}_{[\text{injury}]}$ is $0.207 + 0.189 = 0.396$. The OUV for the specific reported uses has been summarized and presented in Appendix F.

The following 36 tables list the RU, PPV, Specific Reported Use, SU, IUV and OUV for each of the 18 plants as reported by the 40 respondents from Morichitos and España. Also following each use value table is a graph of total Overall Use Values for each plant for both villages combined (Figures 5.5-5.22).

Table 5.11. Use Values for *Mango (Mangifera indica L.)*, village of Morichitos.

$\Sigma RU = 53$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
16 (lf)	0.302				
		injury	6	0.375	0.113
		diarrhea	5	0.313	0.094
		wound	2	0.125	0.038
		headache	1	0.063	0.019
		makes flower	1	0.063	0.019
		bathe child	1	0.063	0.019
20 (fr)	0.377				
		eat	20	1.000	0.377
2 (fw)	0.038				
		to give fruit	2	1.000	0.037
14 (bk)	0.264				
		injury	5	0.357	0.094
		wound	5	0.357	0.094
		diarrhea	2	0.143	0.038
		scabies wound	1	0.071	0.019
		bathe mother	1	0.071	0.019
1 (rt)	0.019				
		toothache	1	1.000	0.019
0 (ot)	0.000				

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.12. Use Values for *Mango (Mangifera indica L.)*, village of España. **$\Sigma RU = 37$**

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
10 (lf)	0.270	diarrhea	5	0.500	0.135
		injury	4	0.400	0.108
		fever and diarrhea	1	0.100	0.027
19 (fr)	0.514	eat	19	1.000	0.514
3 (fw)	0.081	to give fruit	2	0.667	0.054
		injury	1	0.333	0.027
3 (bk)	0.081	injury	2	0.667	0.054
		diarrhea	1	0.333	0.027
1 (rt)	0.027	diarrhea	1	1.000	0.027
1 (ot)	0.027	quench thirst	1	1.000	0.027

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.5.
Comparison of Overall Use Values for Specific Reported Uses
for *Mango (Mangifera indica L.)*.

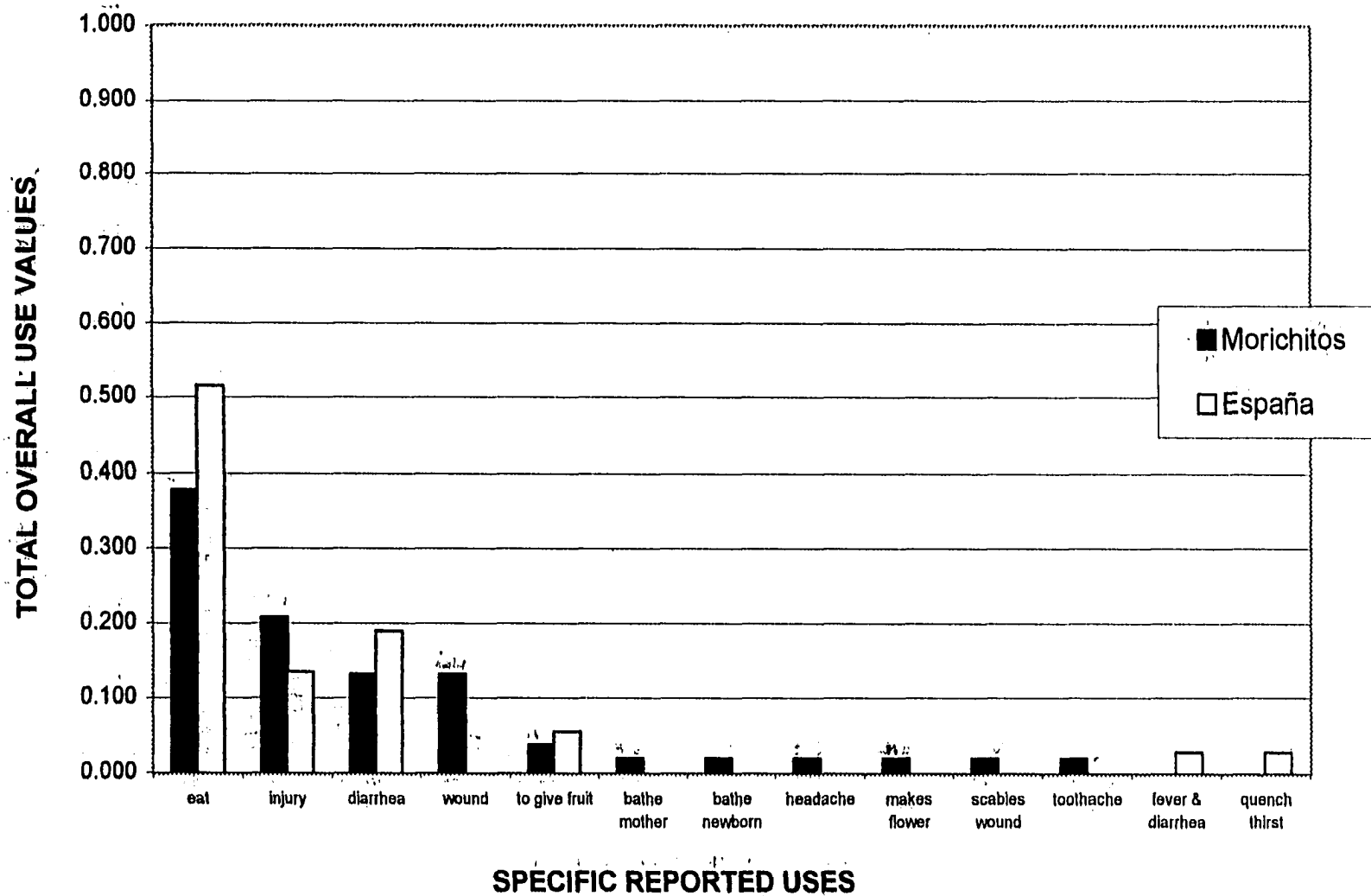


Table 5.13. Use Values for *Usiru* (*Spondias mombin* L.), village of Morichitos.

$\Sigma RU = 32$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
9 (lf)	0.281	diarrhea	9	1.000	0.281
15 (fr)	0.469	eat	14	0.933	0.438
		vomiting	1	0.067	0.031
1 (fw)	0.031	to give fruit	1	1.000	0.031
7 (bk)	0.219	diarrhea	5	0.714	0.156
		diarrhea and vomiting	1	0.143	0.031
		wound	1	0.143	0.031
0 (rt)	0.000				
0 (ot)	0.000				

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.14. Use values for *Usiru* (*Spondias mombin* L.), village of España. **Σ RU = 39**

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
13 (lf)	0.333				
		diarrhea	8	0.615	0.205
		grippe	2	0.154	0.051
		diarrhea and vomiting	1	0.077	0.026
		sick child	1	0.077	0.026
		all use	1	0.077	0.026
17 (fr)	0.424				
		eat	17	1.000	0.424
3 (fw)	0.077				
		to give fruit	3	1.000	0.077
5 (bk)	0.128				
		diarrhea	3	0.600	0.077
		diarrhea and vomiting	1	0.200	0.026
		calm pain	1	0.200	0.026
1 (rt)	0.026				
		diarrhea	1	1.000	0.026
0 (ot)	0.000				

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.6.
Comparison of Overall Use Values for Specific Reported Uses
for *Usiru* (*Spondias mombin* L.).

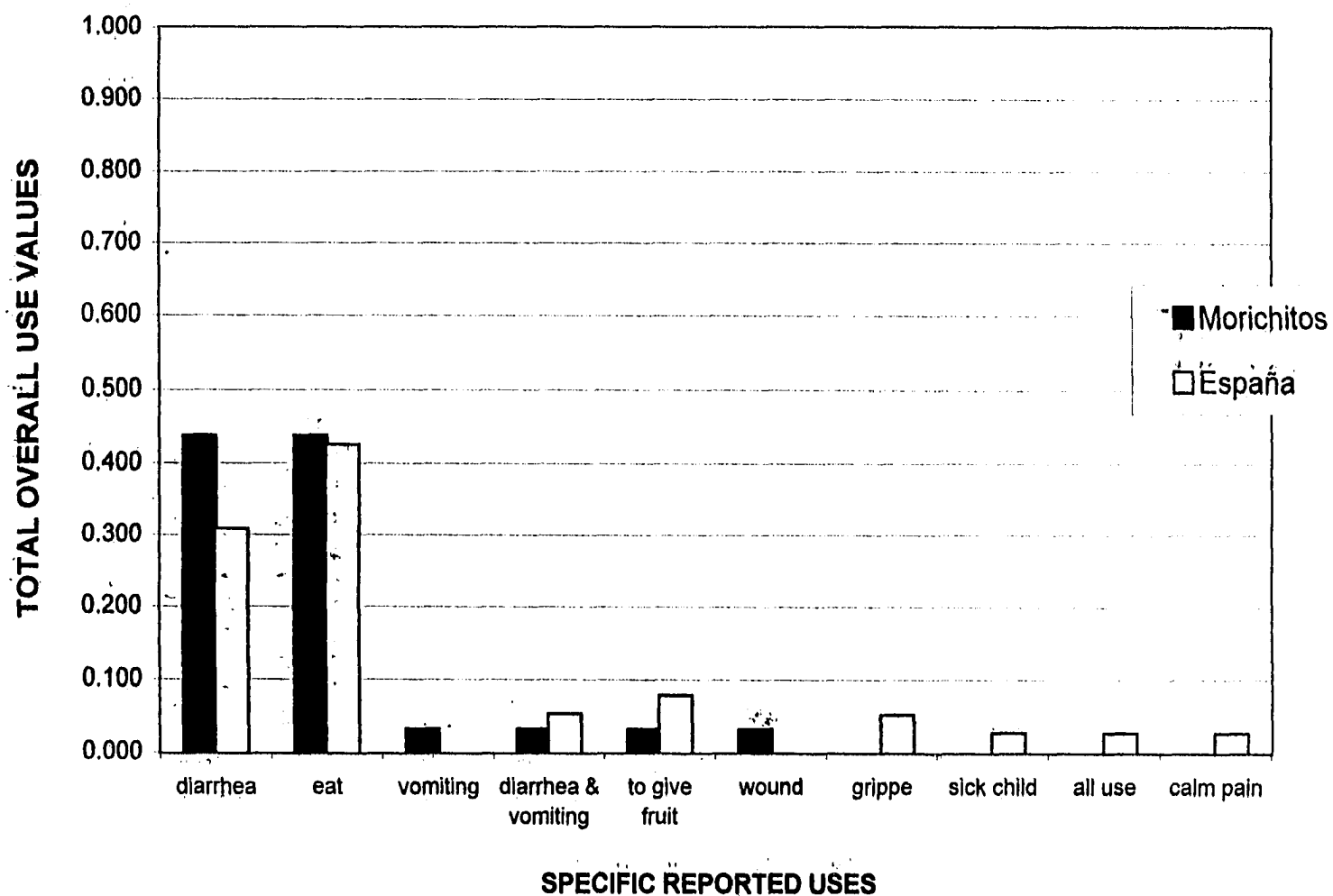


Table 5.15. Use values for *Hemuru* (*Montrichardia aborescens* (L.) Schott), village of Morichitos.

$\Sigma RU = 18$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
3 (lf)	0.167	fishing	2	0.667	0.111
		wasp sting	1	0.333	0.056
8 (fr)	0.444	fish bait	8	1.000	0.444
5 (fw)	0.278	fish bait	5	1.000	0.278
0 (bk)	0.000				
0 (rt)	0.000				
2 (ot)	0.111	wasp sting	1	0.500	0.056
		toy canoe	1	0.500	0.056

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.16. Use values for *Hemuru* (*Montrichardia aborescens* (L.) Schott), village of España.

Σ RU = 16

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
1 (lf)	0.063	lining of basket	1	1.000	0.063
12 (fr)	0.750	fish bait	12	1.000	0.750
3 (fw)	0.188	fish bait	3	1.000	0.188
0 (bk)	0.000				
0 (rt)	0.000				
0 (ot)	0.000				

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.7.
Comparison of Overall Use Values for Specific Reported Uses
for *Hemuru* (*Montrichardia aborescens* (L.) Schott).

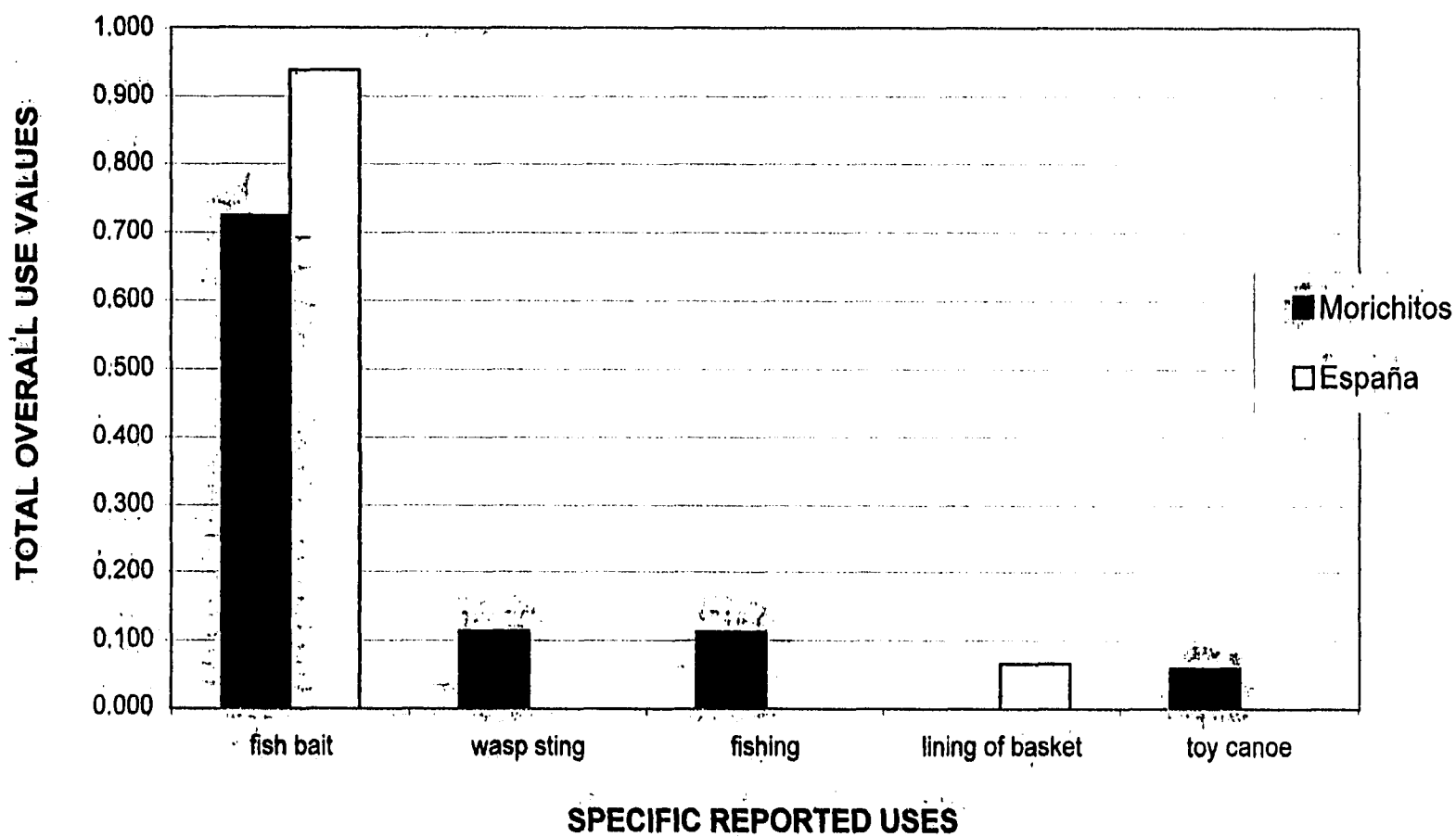


Table 5.17. Use values for *Idu* (*Ceiba pentandra* Gaertn.), village of Morichitos.

$\Sigma RU = 5$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
0 (fr)					
0 (fw)	0.000				
2 (bk)	0.400				
		protection against <i>hebu</i> spirit	1	0.500	0.200
		toothache	1	0.500	0.200
0 (rt)	0.000				
3 (ot)	0.600				
		canoe to bury person	3	1.00	0.600

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.18. Use values for *Idu* (*Ceiba pentandra* Gaertn.), village of España. **Σ RU = 11**

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
2 (lf)	0.182	diarrhea	2	1.000	0.182
1 (fr)	0.091	fever	1	1.000	0.091
3 (fw)	0.273	diarrhea	1	0.333	0.091
		protection against <i>hebu</i> spirit	1	0.333	0.091
		to give fruit	1	0.333	0.091
3 (bk)	0.273	diarrhea	2	0.667	0.182
		fever	1	0.333	0.091
0 (rt)	0.000				
2 (ot)	0.182	canoe to bury person	1	0.500	0.091
		canoe	1	0.500	0.091

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.8.
Comparison of Overall Use Values for Specific Reported Uses
for *Idu* (*Ceiba pentandra* Gaertn.).

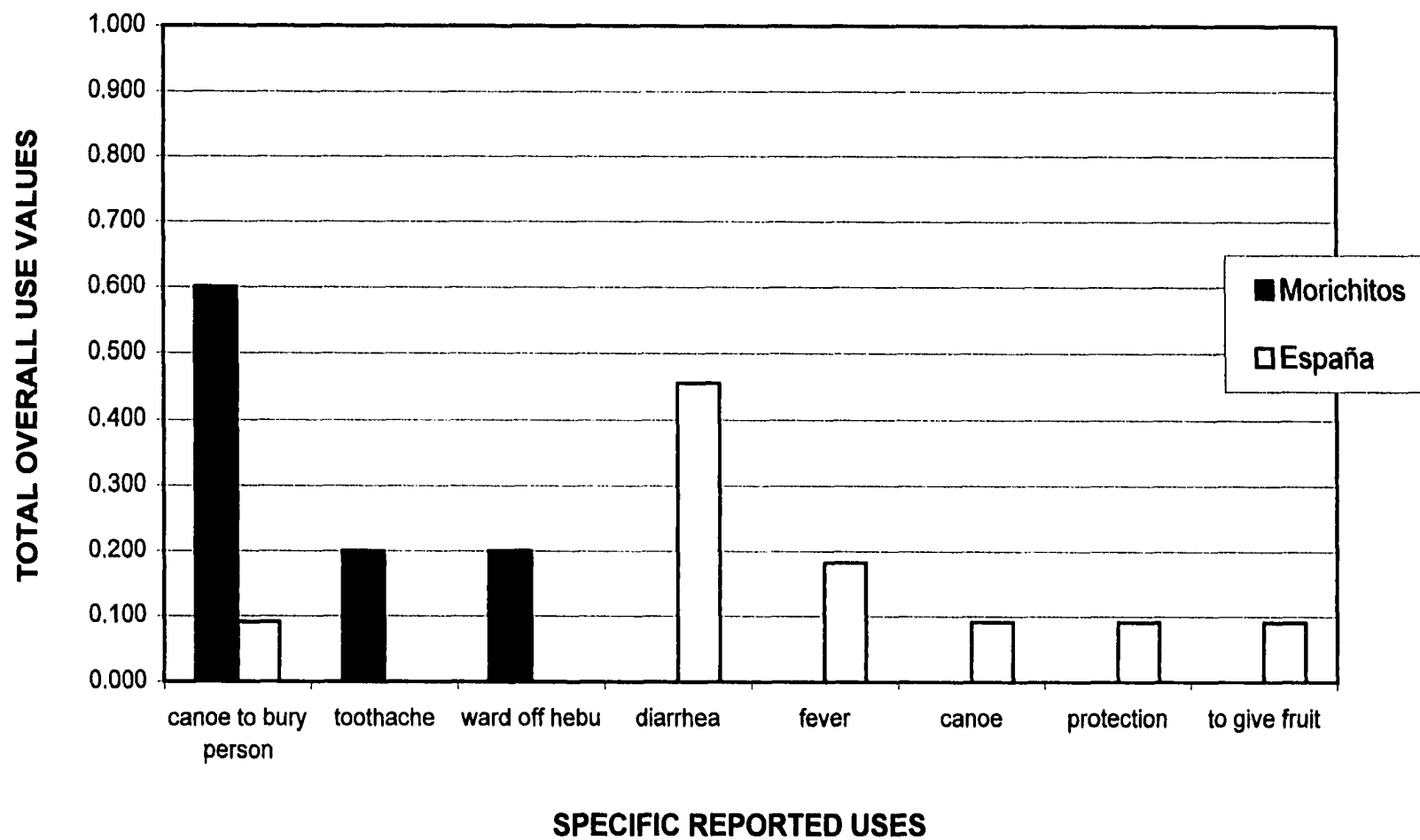


Table 5.19. Use values for *Homoarao* (*Pachira aquatica* Aubl.), village of Morichitos.

$\Sigma RU = 18$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
15 (fr)	0.833	eat grippe	12 3	0.800 0.200	0.666 0.167
1 (fw)	0.056	fish bait	1	1.000	0.056
2 (bk)	0.111	snake bite	2	1.000	0.111
0 (rt)	0.000				
0 (ot)	0.000				

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.20. Use values for *Homoarao* (*Pachira aquatica* Aubl.), village of España.

$\Sigma RU = 14$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
12 (fr)	0.857	eat	9	0.750	0.643
		grippe	2	0.167	0.143
		grippe, catarrh, fever	1	0.083	0.071
1 (fw)	0.071	to give fruit	1	1.000	0.071
1 (bk)	0.071	fever	1	1.000	0.071
0 (rt)	0.000				
0 (ot)	0.000				

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.9.
Comparison of Overall Use Values for Specific Reported Uses
for *Homoarao* (*Pachira aquatica* Aubl.).

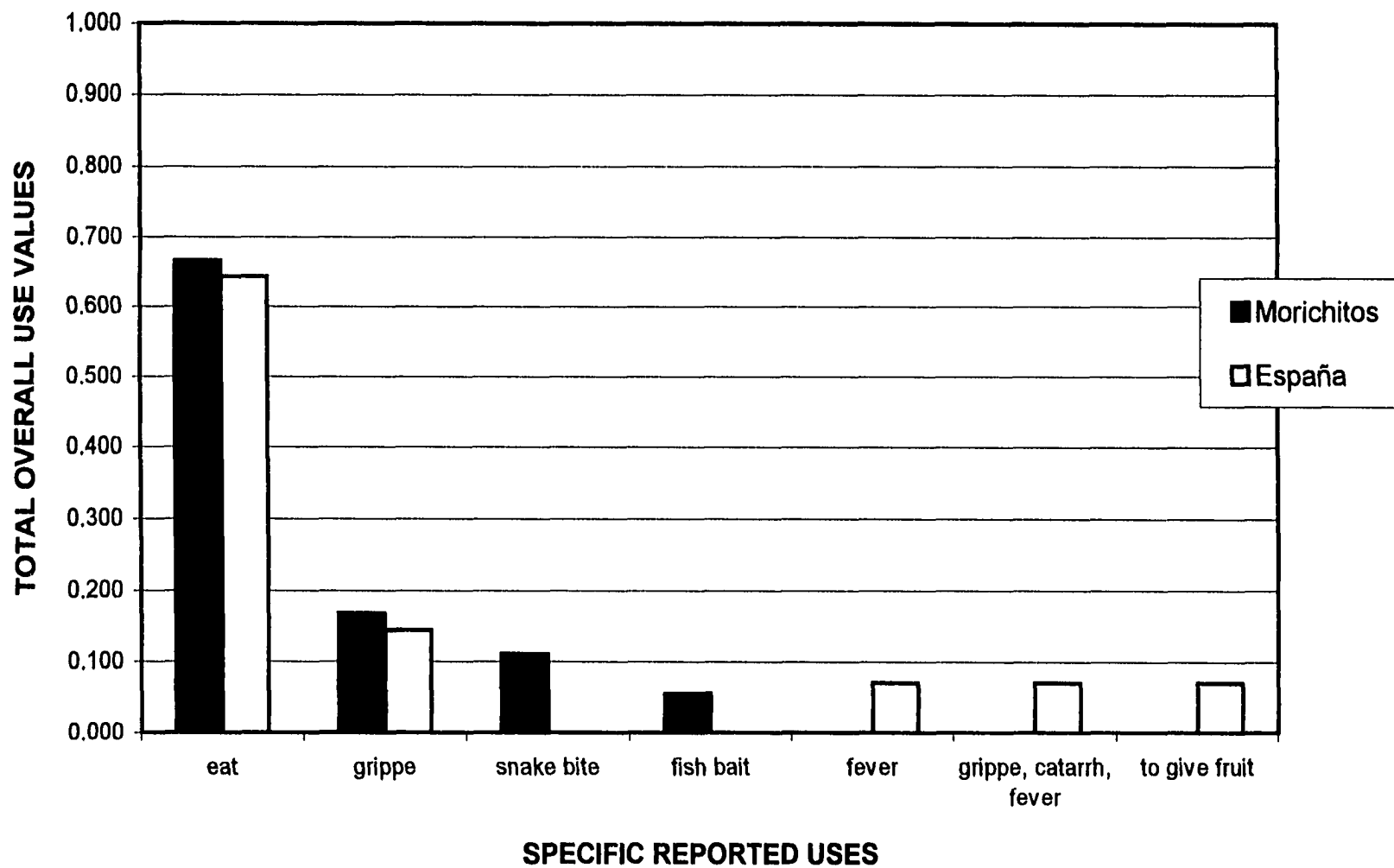


Table 5.21. Use values for *Sibu (Protium guianense (Aubl.) March.)*, village of Morichitos.

$\Sigma RU = 22$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
3 (lf)	0.136	grippe	3	1.000	0.136
2 (fr)	0.091	grippe	2	1.000	0.091
0 (fw)	0.000				
17 (bk)	0.773	grippe	14	0.824	0.637
		fever and headache	1	0.059	0.046
		fever, diarrhea, grippe	1	0.059	0.046
		toothache	1	0.059	0.046
0 (rt)	0.000				
0 (ot)	0.000				

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.22. Use values for *Sibu* (*Protium guianense* (Aubl.) March.), village of España.

$\Sigma RU = 22$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
2 (lf)	0.091				
		grippe	1	0.500	0.045
		diarrhea	1	0.500	0.045
2 (fr)	0.091				
		grippe	2	1.000	0.083
1 (fw)	0.045				
		grippe	1	1.000	0.042
16 (bk)	0.727				
		grippe	10	0.625	0.454
		fever, headache, & cough	1	0.063	0.045
		catarrh	2	0.125	0.091
		fever	1	0.063	0.045
		diarrhea	1	0.063	0.045
		necklace for child	1	0.063	0.045
1 (rt)	0.045				
		firewood	1	1.000	0.045
0 (ot)	0.000				

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.10.
Comparison of Overall Use Values for Specific Reported Uses
for *Sibu* (*Protium guianense* (Aubl.) March.).

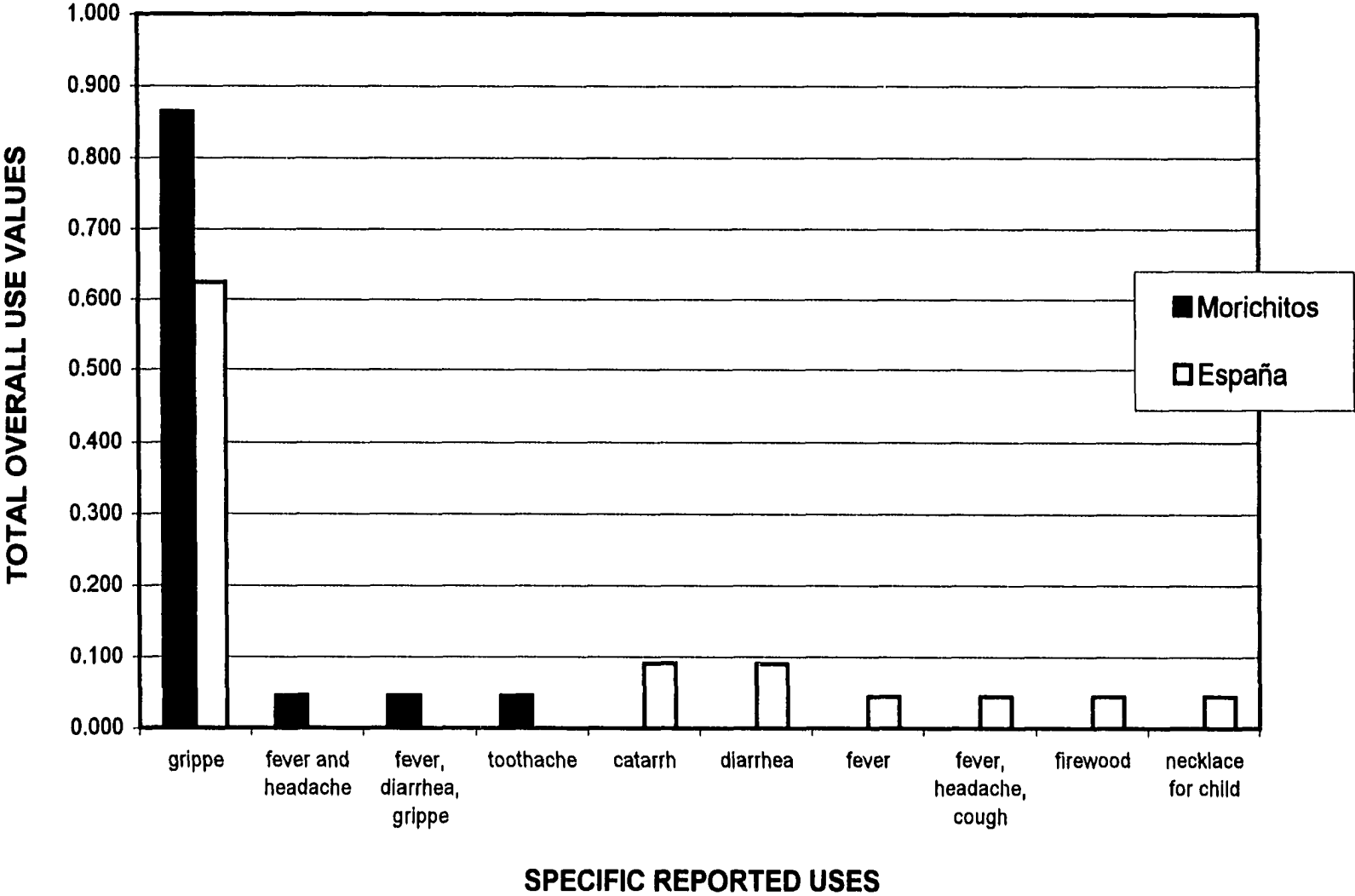


Table 5.23. Use values for *Ohoru* (*Symphonia globulifera* L.f.), village of Morichitos.

$\Sigma RU = 11$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
0 (fr)	0.000				
0 (fw)	0.000				
6 (bk)	0.545	wound	6	1.000	0.545
0 (rt)	0.000				
5 (ot)	0.454	canoe	4	0.800	0.363
		flat sawn boards	1	0.200	0.091

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.24. Use values for *Ohoru* (*Symphonia globulifera* L.f.), village of España.

$\Sigma RU = 13$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
1 (lf)	0.077	fever	1	1.000	0.077
1 (fr)	0.077	to give fruit	1	1.000	0.077
0 (fw)	0.000				
5 (bk)	0.385	wound	4	0.800	0.308
		canoe	1	0.200	0.077
3 (rt)	0.231	canoe	2	0.667	0.154
		wound	1	0.333	0.077
3 (ot)	0.231	canoe	3	1.000	0.231

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.11.
Comparison of Overall Use Values for Specific Reported Uses
for Ohoru (*Symphonia globulifera* L.f.).

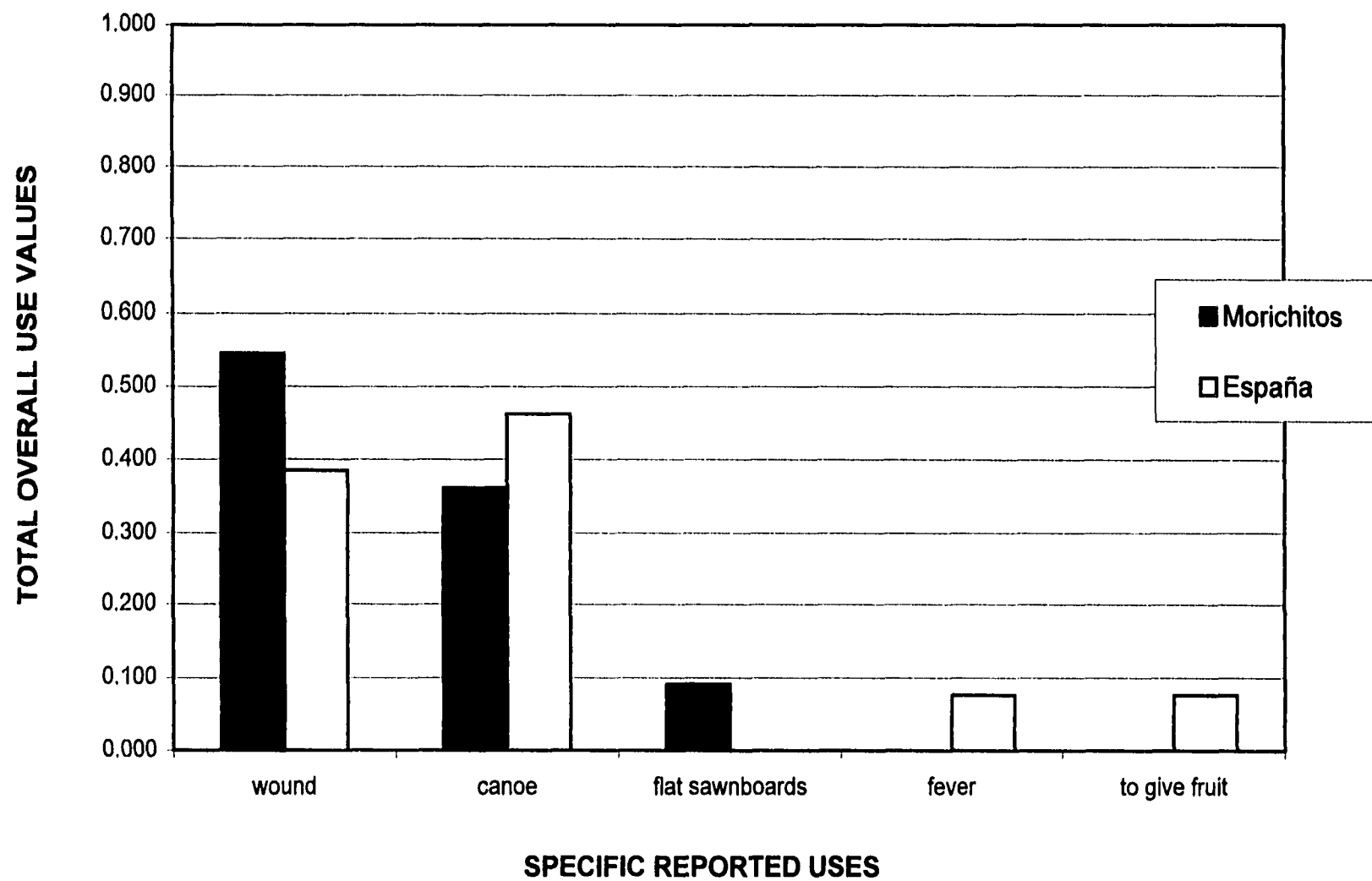


Table 5.25. Use values for *Korokororo* (*Hernandia sonora* L.), village of Morichitos.

Σ RU = 19

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
3 (lf)	0.158				
		grippe	2	0.667	0.105
		bathe child	1	0.333	0.053
1 (fr)	0.053				
		wound	1	1.000	0.053
0 (fw)	0.000				
13 (bk)	0.684				
		grippe	8	0.615	0.421
		fever	1	0.077	0.053
		fever and grippe	1	0.077	0.053
		scabies	1	0.077	0.053
		toy canoe	1	0.077	0.053
		bathe child	1	0.077	0.053
0 (rt)	0.000				
2 (ot)	0.105				
		flat sawn boards	2	1.000	0.105

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.26. Use values for *Korokororo* (*Hernandia sonora* L.), village of España.

$\Sigma RU = 20$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
3 (lf)	0.150	fever	1	0.333	0.050
		fever and grippe	1	0.333	0.050
		fever and catarrh	1	0.333	0.050
2 (fr)	0.100	toy canoe	2	1.000	0.100
1 (fw)	0.050	to give fruit	1	1.000	0.050
12 (bk)	0.600	grippe	4	0.333	0.200
		fever	3	0.250	0.150
		fever and catarrh	2	0.167	0.100
		fever, diarrhea, "all illness"	1	0.083	0.050
		diarrhea and grippe	1	0.083	0.050
2 (rt)	0.100	flat sawn boards	1	0.500	0.050
		toy canoe	1	0.500	0.050
1 (ot)	0.050	flat sawn boards	1	1.000	0.050

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.12.
Comparison of Overall Use Values for Specific Reported Uses
for Korokororo (*Hernandia sonora* L.).

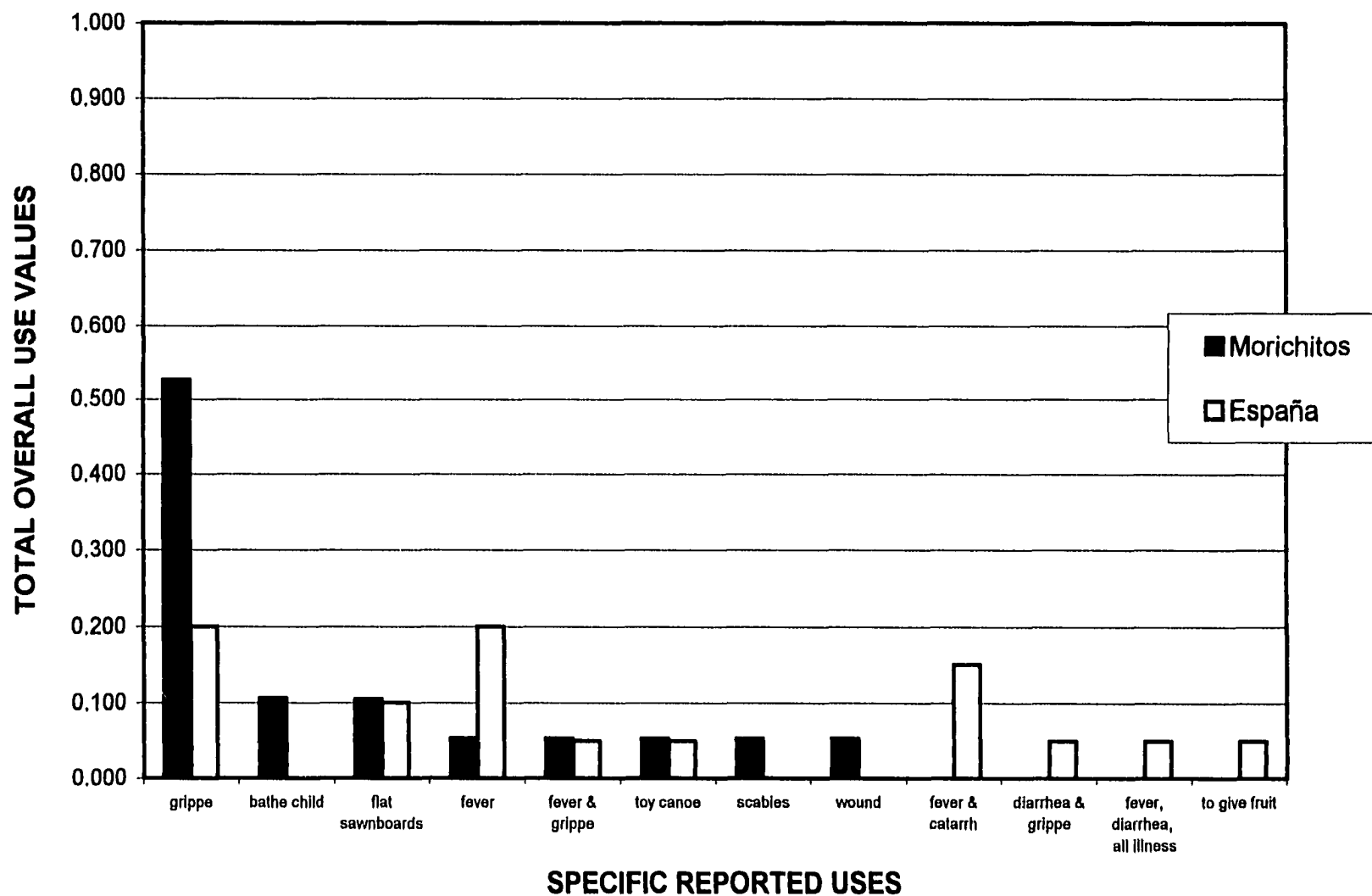


Table 5.27. Use values for *Nasinaba* (*Ocotea* sp. Aubl.), village of Morichitos.

$\Sigma RU = 25$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
2 (lf)	0.080	fever	1	0.500	0.040
		fever and grippe	1	0.500	0.040
19 (fr)	0.760	grippe	9	0.500	0.360
		fever and grippe	2	0.100	0.080
		vomiting	2	0.100	0.080
		necklace	2	0.050	0.080
		diarrhea and grippe	1	0.100	0.040
		fever and diarrhea	1	0.100	0.040
		protection against <i>hebu</i> spirit	1	0.050	0.040
		diarrhea	1	0.053	0.040
1 (fw)	0.040	to give fruit	1	1.000	0.040
3 (bk)	0.120	grippe	2	0.667	0.080
		prevent illness	1	0.333	0.040
0 (rt)	0.000				
0 (ot)	0.000				

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.28. Use values for *Nasinaba* (*Ocotea* sp. Aubl.), village of España. **Σ RU = 33**

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
5 (lf)	0.151				
		grippe	2	0.400	0.060
		fever	1	0.200	0.030
		fever and catarrh	1	0.200	0.030
		diarrhea	1	0.200	0.020
20 (fr)	0.606				
		grippe	9	0.450	0.273
		diarrhea	2	0.100	0.060
		necklace	2	0.100	0.030
		fever and grippe	1	0.050	0.030
		diarrhea and grippe	1	0.050	0.030
		fever, grippe, catarrh	1	0.050	0.030
		fever	1	0.050	0.030
		fever and catarrh	1	0.050	0.030
		fever and diarrhea	1	0.050	0.030
		vomiting	1	0.050	0.030
1 (fw)	0.030				
		to give fruit	1	1.000	0.030
7 (bk)	0.212				
		grippe	5	0.714	0.151
		fever and grippe	1	0.143	0.030
		fever and diarrhea	1	0.143	0.030
0 (rt)	0.000				
0 (ot)	0.000				

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.13.
Comparison of Overall Use Values for Specific Reported Uses
for *Nasinaba* (*Ocotea* sp. Aubl.).

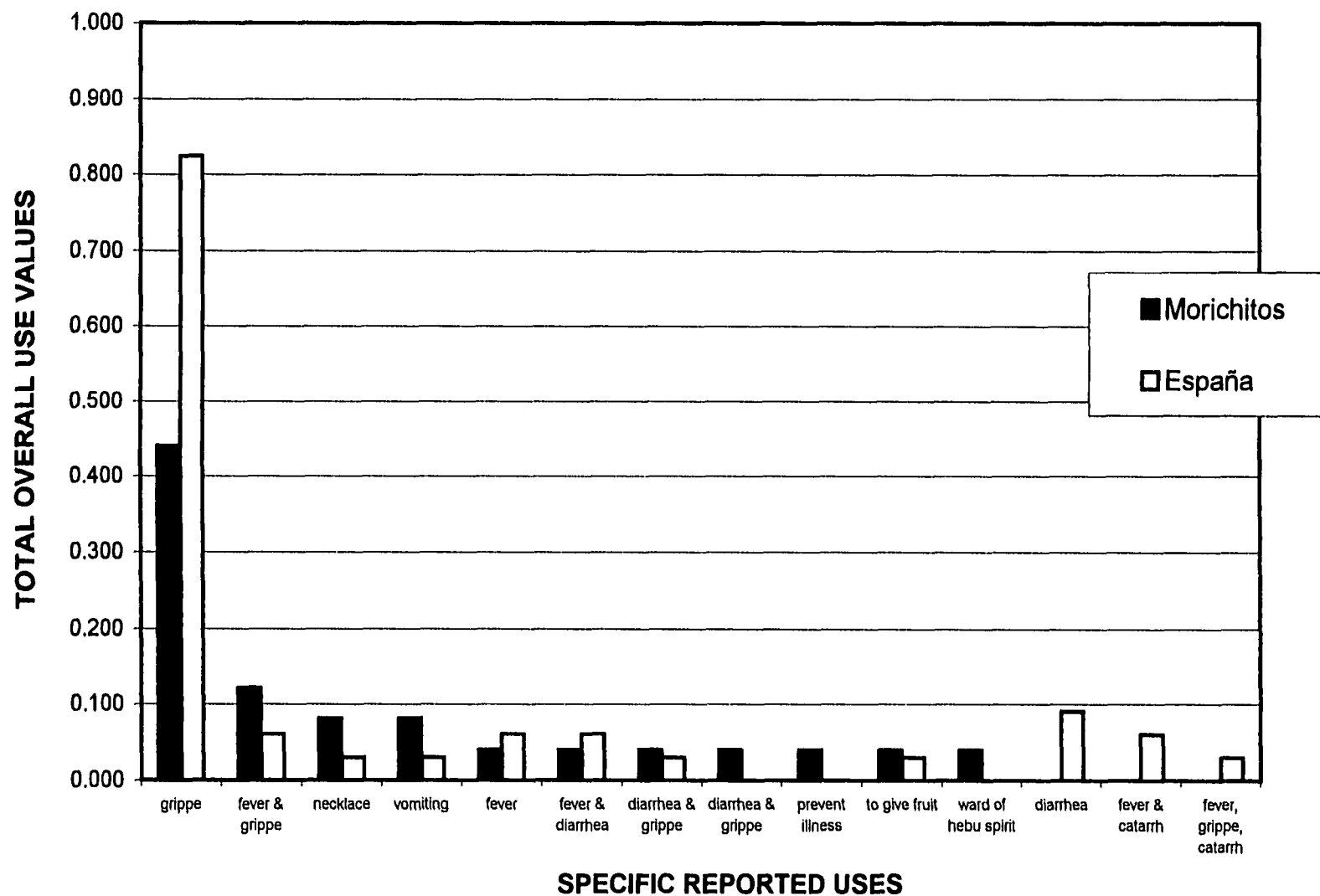


Table 5.29. Use values for *Bihibihidu* (*Pentaclethra macroloba* Kuntze), village of Morichitos.

$\Sigma RU = 9$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
0 (fr)	0.000				
0 (fw)	0.000				
9 (bk)	1.000				
		diarrhea	3	0.333	0.333
		diarrhea w green stool	1	0.111	0.111
		diarrhea with blood	1	0.111	0.111
		wound	1	0.111	0.111
		feeling bad	1	0.111	0.111
		intestinal worms	1	0.111	0.111
		firewood	1	0.111	0.111
0 (rt)	0.000				
0 (ot)	0.000				

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.30. Use values for *Bihibihidu* (*Pentaclethra macroloba* Kuntze), village of España.

$\Sigma RU = 2$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
0 (fr)	0.000				
0 (fw)	0.000				
1 (bk)	0.500	diarrhea with blood	1	1.000	0.500
0 (rt)	0.000				
1 (ot)	0.500	firewood	1	1.000	0.500

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.14.
Comparison of Overall Use Values for Specific Reported Uses
for *Bihibihidu* (*Pentaclethra macroloba* Kuntze).

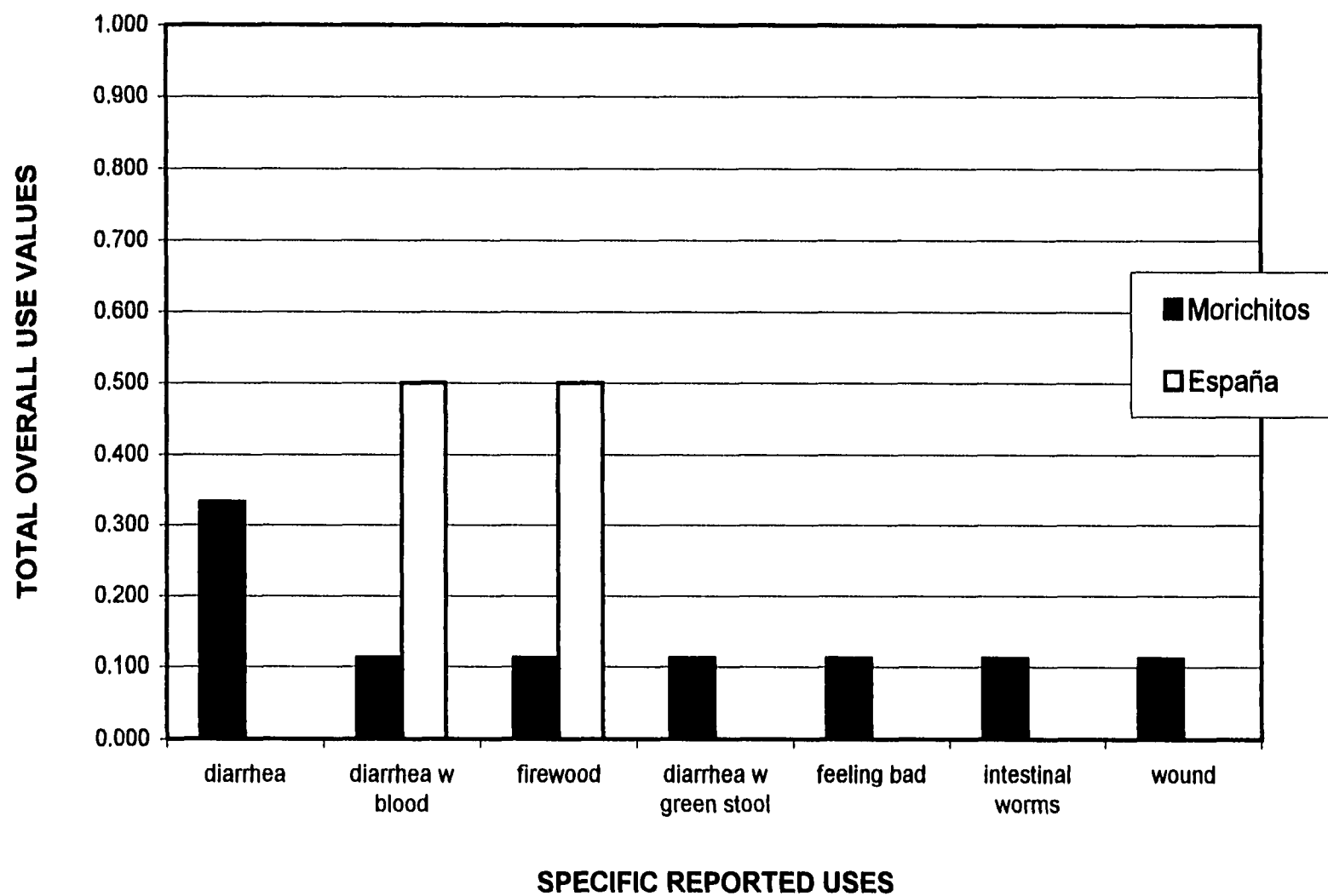


Table 5.31. Use values for *Iburu* (*Pterocarpus officinalis* Jacq.), village of Morichitos.

$\Sigma RU = 15$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
2 (fr)	0.133	honey	2	1.000	0.133
3 (fw)	0.200	honey	3	1.000	0.200
10 (bk)	0.667	mouth sore	5	0.500	0.333
		diarrhea with intestinal worms	1	0.100	0.067
		diarrhea with blood	1	0.100	0.067
		toothache	1	0.100	0.067
		wound	1	0.100	0.067
		toy canoe	1	0.100	0.067
0 (rt)	0.000				
0 (ot)	0.000				

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.32. Use values for *Iburu* (*Pterocarpus officinalis* Jacq.), village of España.

$\Sigma RU = 15$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
6 (fr)	0.400	eat	5	0.833	0.333
		honey indicator	1	0.167	0.067
3 (fw)	0.200	honey	3	1.000	0.200
4 (bk)	0.267	diarrhea	1	0.250	0.067
		diarrhea with blood	1	0.250	0.067
		mouth sore	1	0.250	0.067
		honey, get from trunk	1	0.250	0.067
1 (rt)	0.071	firewood	1	1.000	0.071
1 (ot)	0.071	toy canoe	1	1.000	0.071

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.15.
Comparison of Overall Use Values for Specific Reported Uses
for Iburu (*Pterocarpus officinalis* Jacq.).

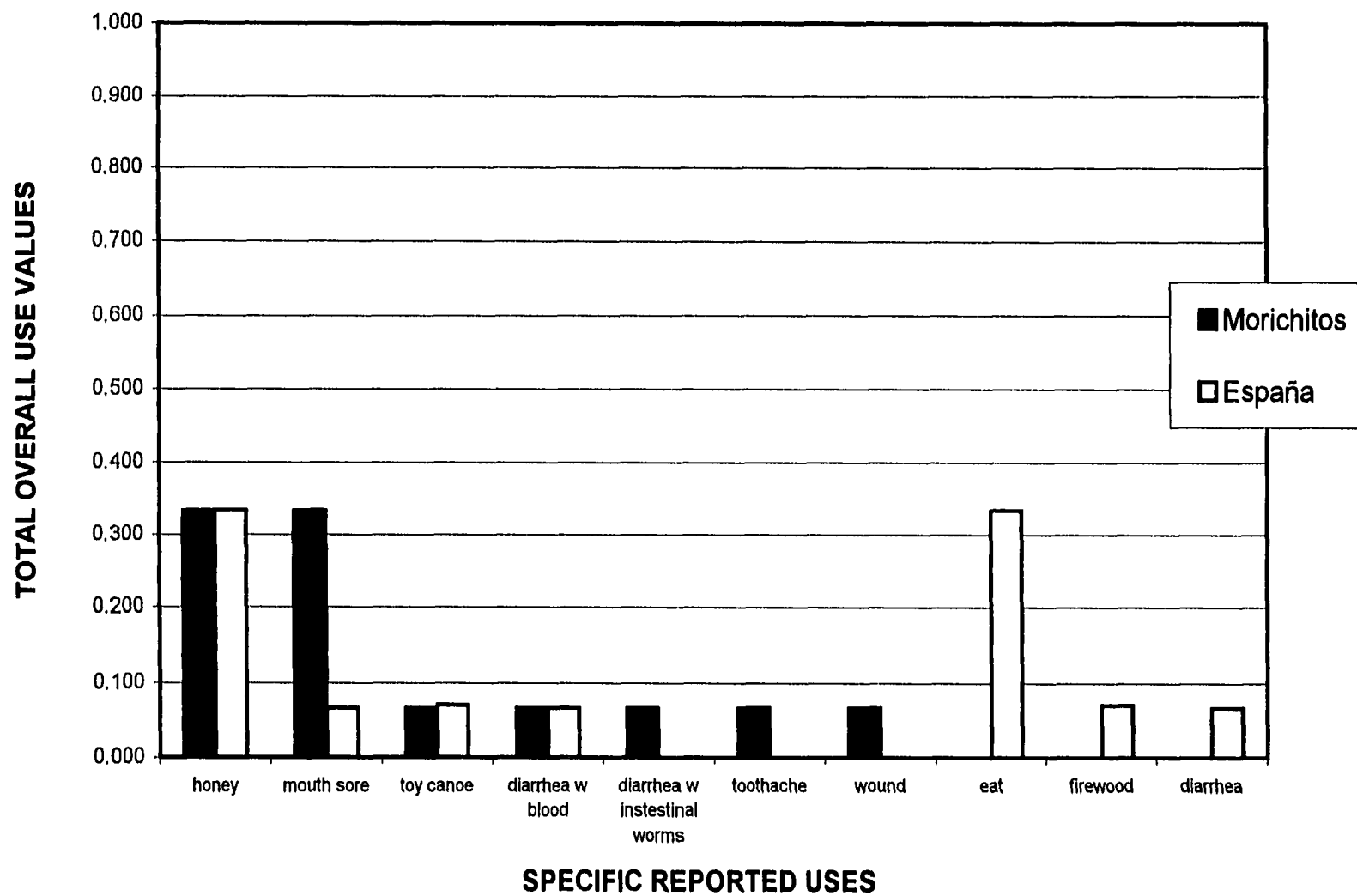


Table 5.33. Use values for *Kuahineru* (*Pterocarpus* sp. Jacq.), village of Morichitos.

$\Sigma RU = 4$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
2 (fr)	0.500	bleach	2	1.000	0.500
0 (fw)					
2 (bk)	0.500	mouth sore	2	1.000	0.500
0 (rt)	0.000				
0 (ot)	0.000				

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.34. Use values for *Kuahineru* (*Pterocarpus* sp. Jacq.), village of España.

$\Sigma RU = 5$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
2 (lf)	0.400	bleach	2	1.000	0.400
1 (fr)	0.200	bleach	1	1.000	0.200
0 (fw)	0.000				
1 (bk)	0.200	mouth sore	1	1.000	0.200
0 (rt)	0.000				
2 (ot)	0.200	bleach	1	1.000	0.200

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.16.
Comparison of Overall Use Values for Specific Reported Uses
for *Kuahineru* (*Pterocarpus* sp. Jacq.).

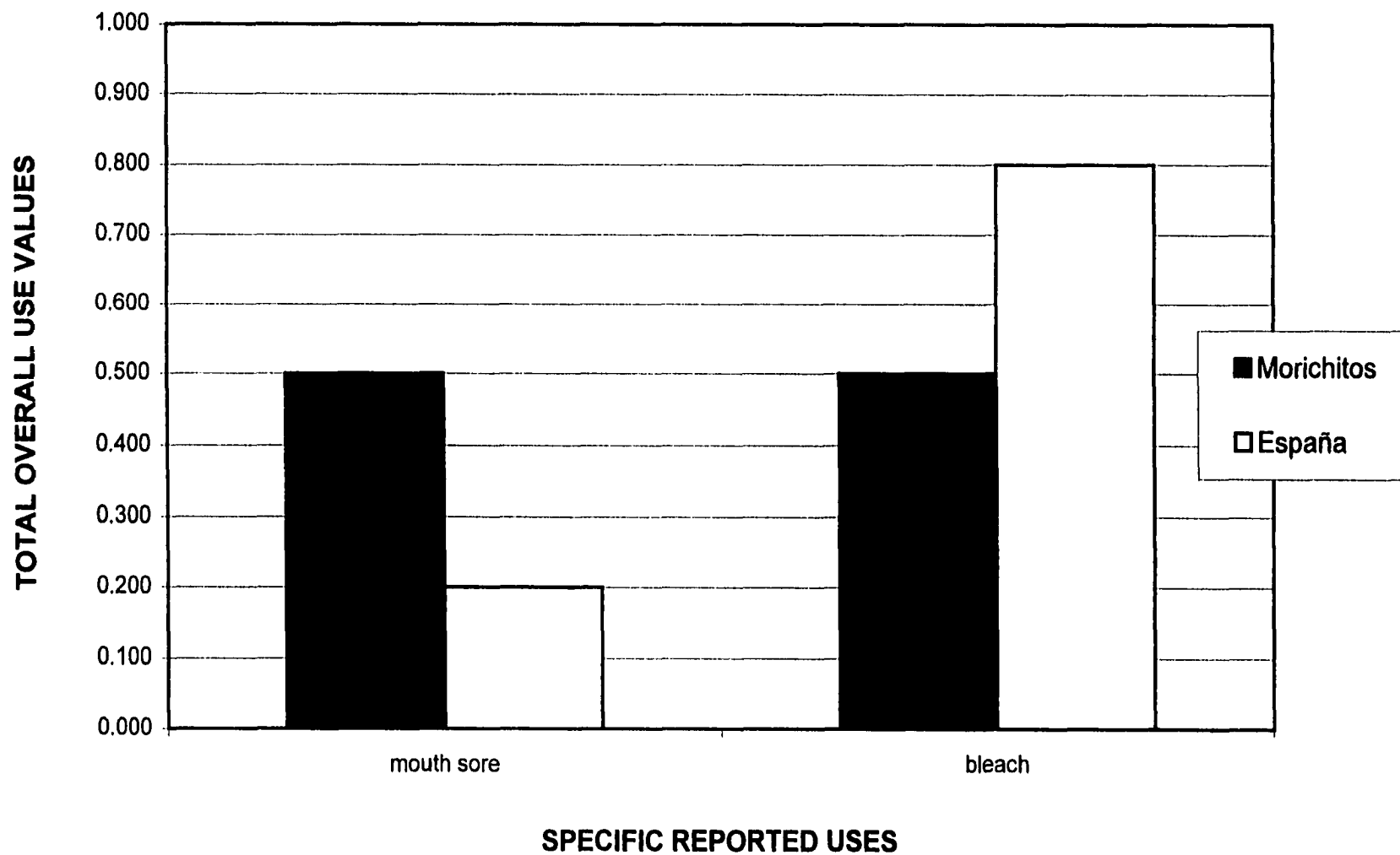


Table 5.35. Use values for *Samariya* (*Cedrela fissilis* Vell.), village of Morichitos.

$\Sigma RU = 13$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
0 (fr)	0.000				
0 (fw)	0.000				
4 (bk)	0.308				
		stingray wound	2	0.500	0.154
		oar	2	0.500	0.154
0 (rt)	0.000				
9 (ot)	0.692				
		canoe	3	0.333	0.230
		chair	2	0.222	0.154
		table	2	0.222	0.154
		flat sawnboards	1	0.111	0.077
		oar	1	0.111	0.077

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.36. Use values for *Samariya* (*Cedrela fissilis* Vell.), village of España.

$\Sigma RU = 15$

ΣRU [plant part]	PPV	Specific Reported Use	SU [plant part]	IUV	OUV
0 (lf)	0.000				
0 (fr)	0.000				
0 (fw)	0.000				
7 (bk)	0.429				
		canoe	4	0.571	0.267
		stingray wound	1	0.143	0.067
		flat sawnboards	1	0.143	0.067
		oar	1	0.143	0.067
2 (rt)	0.133				
		canoe	2	1.000	0.133
6 (ot)	0.400				
		canoe	2	0.333	0.133
		oar	2	0.333	0.133
		flat sawnboards	2	0.333	0.133

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Figure 5.17.
Comparison of Overall Use Values for Specific Reported Uses
for *Samariya* (*Cedrela fissilis* Vell.).

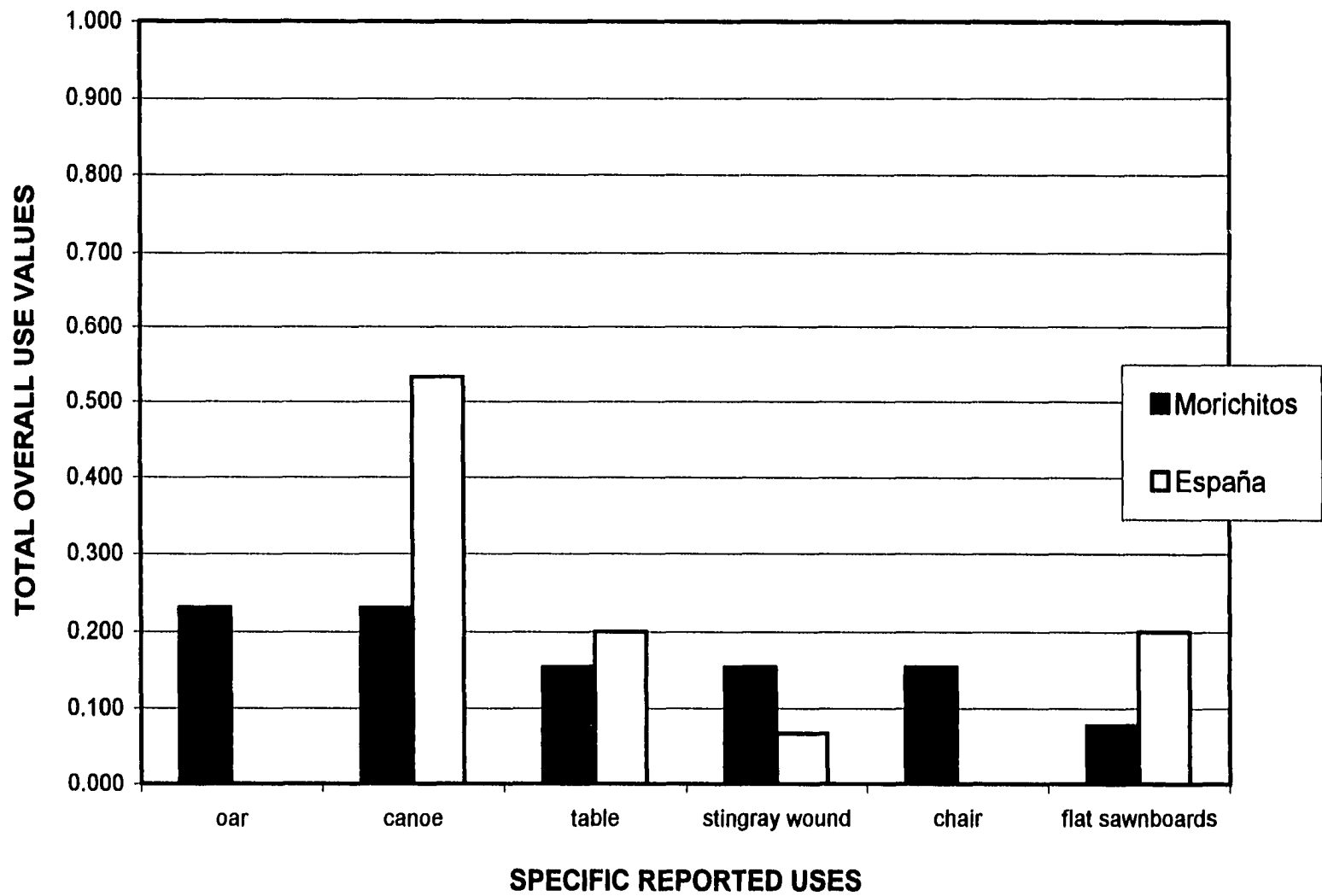


Table 5.37. Use values for *Anare (Euterpe oleracea* Mart.), village of Morichitos.

$\Sigma RU = 47$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
19 (fr)	0.404	eat	19	1.000	0.404
1 (fw)	0.021	to give fruit	1	1.000	0.021
8 (bk)	0.170	diarrhea	3	0.375	0.064
		wound	3	0.375	0.064
		childbirth	1	0.125	0.021
		house floor	1	0.125	0.021
0 (rt)	0.000				
6 (ot)	0.128	diarrhea	2	0.333	0.043
		house floor	2	0.333	0.043
		quench thirst	1	0.167	0.021
		boardwalk	1	0.167	0.021
13 (am)	0.277	eat	13	1.000	0.283
lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)					

Table 5.38. Use values for *Anare (Euterpe oleracea* Mart.), village of España.

$\Sigma RU = 47$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
19 (fr)	0.404	eat	19	1.000	0.404
2 (fw)	0.043	to give fruit	2	1.000	0.043
3 (bk)	0.085	house floor	4	1.000	0.085
4 (rt)	0.085	diarrhea with blood	1	0.250	0.021
		menses, excessive	1	0.250	0.021
		house floor	2	0.500	0.043
1 (ot)	0.021	house floor	1	1.000	0.021
17 (am)	0.362	eat	16	0.941	0.340
		sell for food	1	0.059	0.021
lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)					

Figure 5.18.
Comparison of Overall Use Values for Specific Reported Uses
for Anare (*Euterpe oleracea* Mart.).

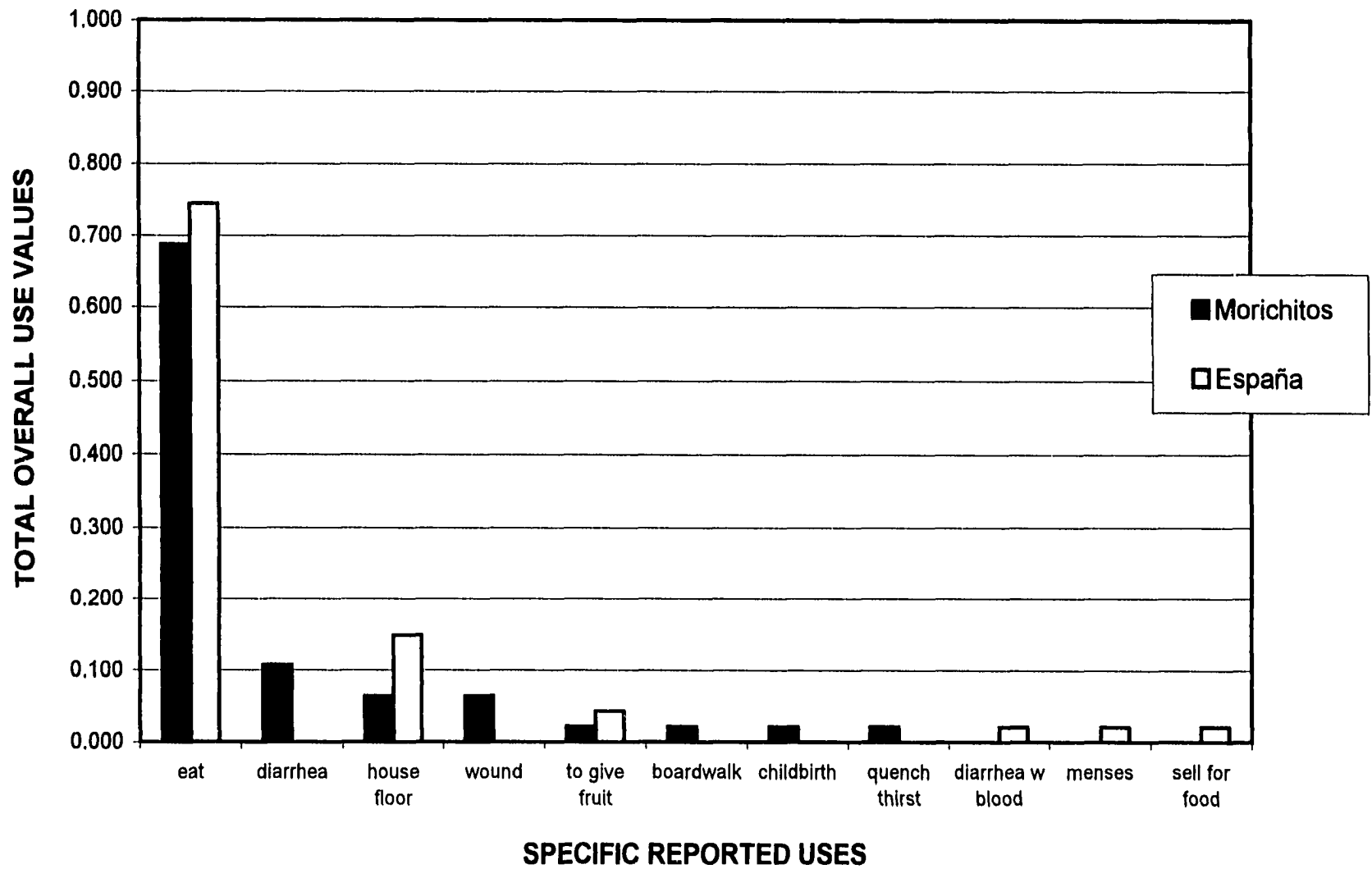


Table 5.39. Use values for *Winamoru* (*Euterpe precatoria* Mart), village of Morichitos.

$\Sigma RU = 23$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
4 (fr)	0.147	eat	4	1.000	0.147
1 (fw)	0.043	to give fruit	1	1.000	0.043
1 (bk)	0.043	wina	1	1.000	0.043
1 (rt)	0.043	cold	1	1.000	0.043
2 (ot)	0.087	wina	2	1.000	0.087
14 (am)	0.609	eat	12	0.857	0.522
		wina	2	0.143	0.087

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)

Table 5.40. Use values for *Winamoru* (*Euterpe precatoria* Mart.), village of España.

Σ RU = 23

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
0 (lf)	0.000				
3 (fr)	0.130	eat	3	1.000	0.130
3 (fw)	0.130	wina	2	0.667	0.087
		to give fruit	1	0.333	0.043
1 (bk)	0.043	wina	1	1.000	0.043
0 (rt)	0.000				
0 (ot)	0.000				
16 (am)	0.696	eat	9	0.563	0.392
		wina	7	0.438	0.305

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)

Figure 5.19.
Comparison of Overall Use Values for Specific Reported Uses
for *Winamoru* (*Euterpe precatoria* Mart.).

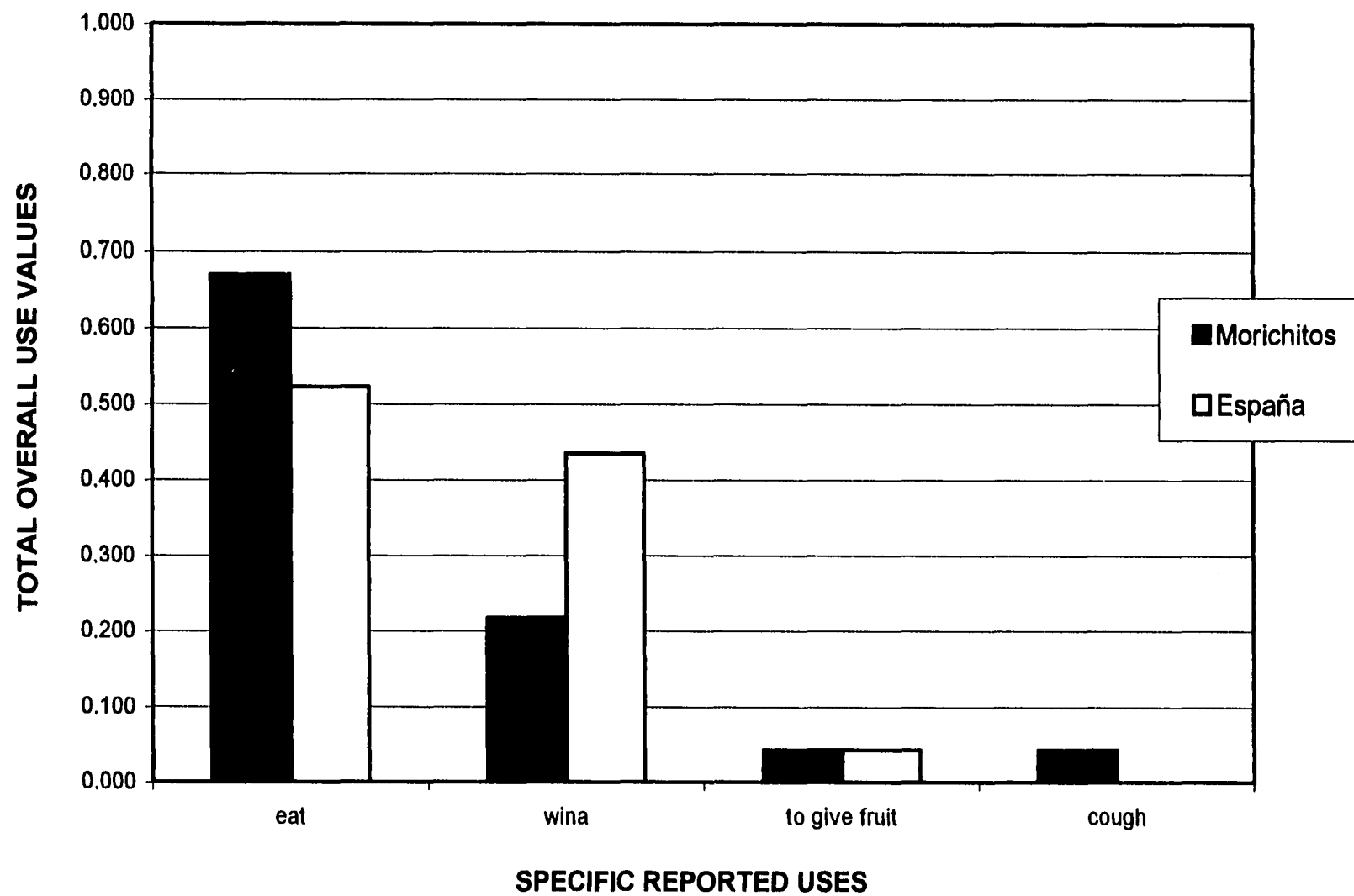


Table 5.41. Use values for *Yaha* (*Manicaria saccifera* Gaertn.), village of Morichitos.

$\Sigma RU = 60$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
19 (lf)	0.317	house (roof, wall)	17	0.895	0.283
		grippe	1	0.053	0.017
		mouth sores	1	0.053	0.017
25 (fr)	0.417	grippe	12	0.522	0.187
		eat	11	0.440	0.183
		cough	1	0.040	0.017
		use to carry things	1	0.040	0.017
1 (fw)	0.017	to give fruit	1	1.000	0.017
0 (bk)	0.000				
0 (rt)	0.000				
0 (ot)	0.000				
15 (am)	0.250	grippe	9	0.533	0.150
		eat	4	0.333	0.067
		cough	2	0.133	0.033

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)

Table 5.42. Use values for *Yaha* (*Manicaria saccifera* Gaertn.), village of España.

$\Sigma RU = 48$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
17 (lf)	0.354	house (roof, wall)	17	1.000	0.354
16 (fr)	0.333	grippe	7	0.438	0.146
		eat	6	0.375	0.125
		cough	1	0.063	0.021
		diarrhea and grippe	1	0.063	0.021
		fever and diarrhea	1	0.063	0.021
1 (fw)	0.021	to give fruit	1	1.000	0.021
0 (bk)	0.000				
0 (rt)	0.000				
0 (ot)	0.000				
14 (am)	0.292	grippe	8	0.571	0.167
		eat	2	0.042	0.042
		catarrh	1	0.071	0.021
		bad cold	1	0.071	0.021
		diarrhea with catarrh	1	0.071	0.021
		give to baby <1 yr.	1	0.071	0.021

lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)

Figure 5.20.
Comparison of Overall Use Values for Specific Reported Uses
for Yaha (*Manicaria saccifera* Gaertn.).

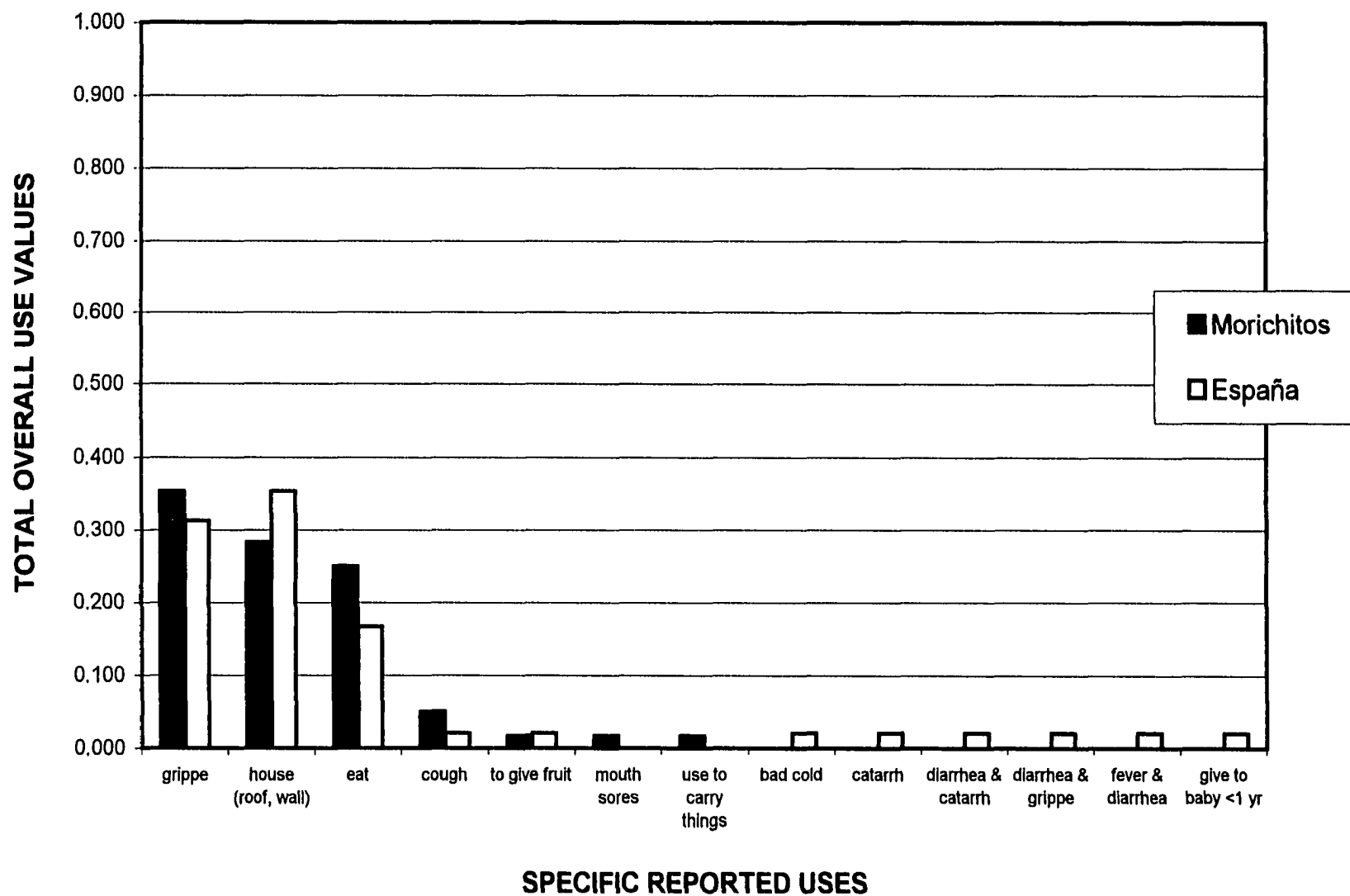


Table 5.43. Use values for *Ohidu* (*Mauritia flexuosa* L.), village of Morichitos.

$\Sigma RU = 82$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
26 (lf)	0.329				
		string for hammock	11	0.423	0.134
		roof-morichal	7	0.269	0.085
		fever	3	0.115	0.037
		folk basket	3	0.115	0.037
		headache	1	0.038	0.012
		bow	1	0.038	0.012
21 (fr)	0.266				
		eat	20	0.952	0.244
		toy	1	0.048	0.012
1 (fw)	0.013				
		to give fruit	1	1.000	0.012
12 (bk)	0.260				
		yuruma	5	0.417	0.061
		wound	3	0.250	0.037
		floor-morichal	2	0.167	0.024
		snake bite	1	0.083	0.012
		water	1	0.083	0.012
0 (rt)					
9 (ot)					
		yuruma	5	0.556	0.061
		floor-morichal	2	0.222	0.024
		maggots from bark-eat	2	0.222	0.024
13 (am)	0.169				
		eat	13	1.000	0.159

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)

Table 5.44. Use values for *Ohidu* (*Mauritia flexuosa* L.), village of España. **$\Sigma RU = 73$**

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
27 (lf)	0.370				
		string for hammock	11	0.407	0.150
		folk basket	10	0.370	0.137
		roof-morichal	6	0.222	0.082
19 (fr)	0.260				
		eat	19	1.000	0.260
1 (fw)	0.014				
		to give fruit	1	1.000	0.014
6 (bk)	0.082				
		yuruma	6	1.000	0.082
1 (rt)	0.014				
		buoy for fishing	1	1.000	0.014
4 (ot)	0.055				
		yuruma	3	0.750	0.041
		maggots from bark-eat	1	0.250	0.014
15 (am)	0.192				
		eat	14	1.933	0.192
		maggots from bark-eat	1	0.067	0.014

If = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem (palm heart)

Figure 5.21.
Comparison of Overall Use Values for Specific Reported Uses
for *Ohidu* (*Mauritia flexuosa* L.f.).

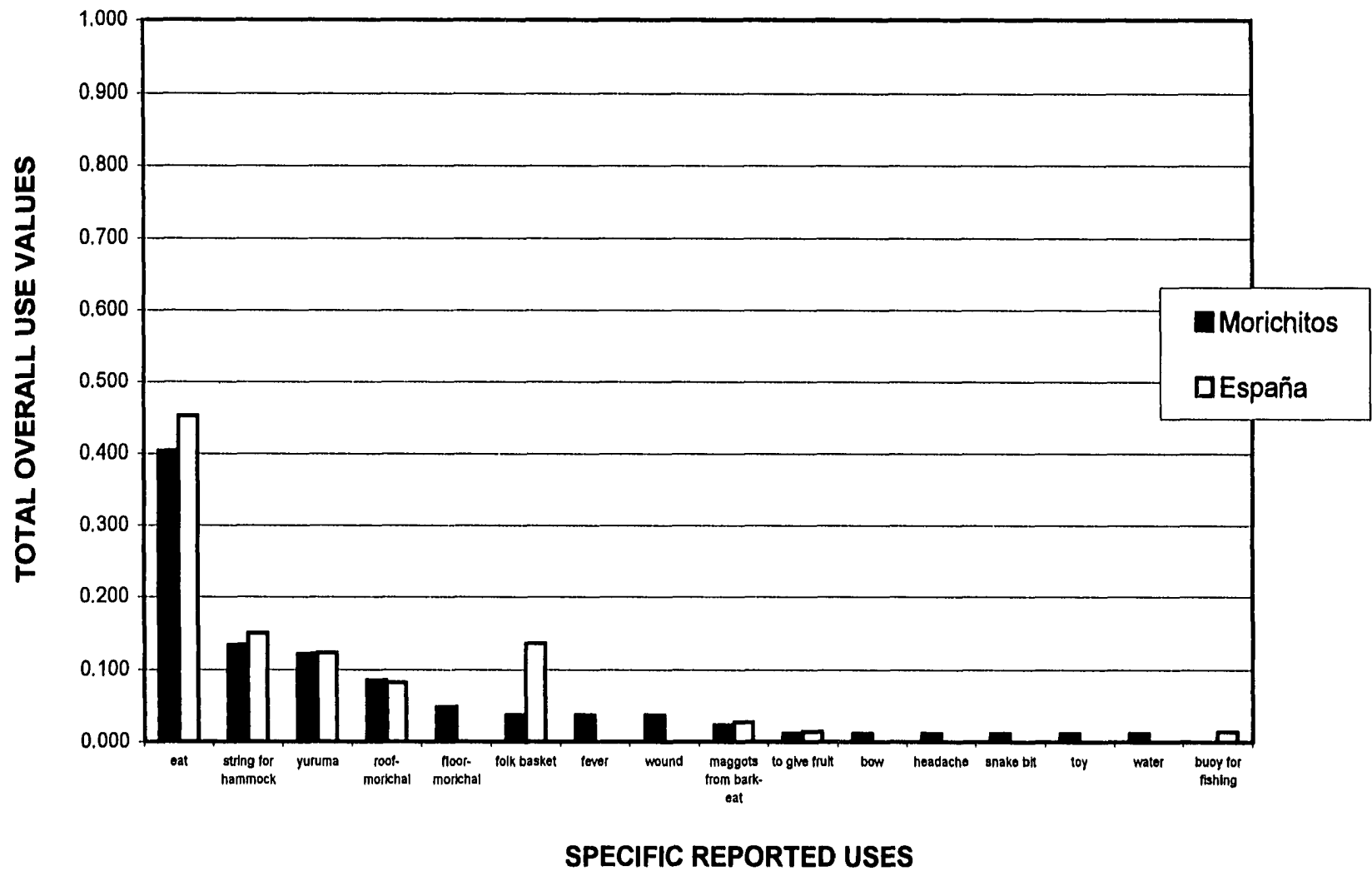


Table 5.45. Use values for *Murusi* (*Renealmia alpinia* (Rottb.) Maas.), village of Morichitos.

$\Sigma RU = 32$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
7 (lf)	0.219				
		newborn	2	0.286	0.063
		grippe	3	0.429	0.094
		fever	1	0.143	0.031
		prevent illness	1	0.143	0.031
12 (fr)	0.375				
		dye	11	0.923	0.344
		grippe	1	0.077	0.031
1 (fw)	0.031				
		to give fruit	1	1.000	0.031
7 (bk)	0.219				
		grippe	4	0.571	0.125
		fever and grippe	1	0.143	0.031
		prevent illness	1	0.143	0.031
		newborn	1	0.143	0.031
4 (rt)	0.125				
		grippe	3	0.750	0.094
		fever and grippe	1	0.250	0.031
1 (ot)	0.031				
		grippe	1	1.000	0.031

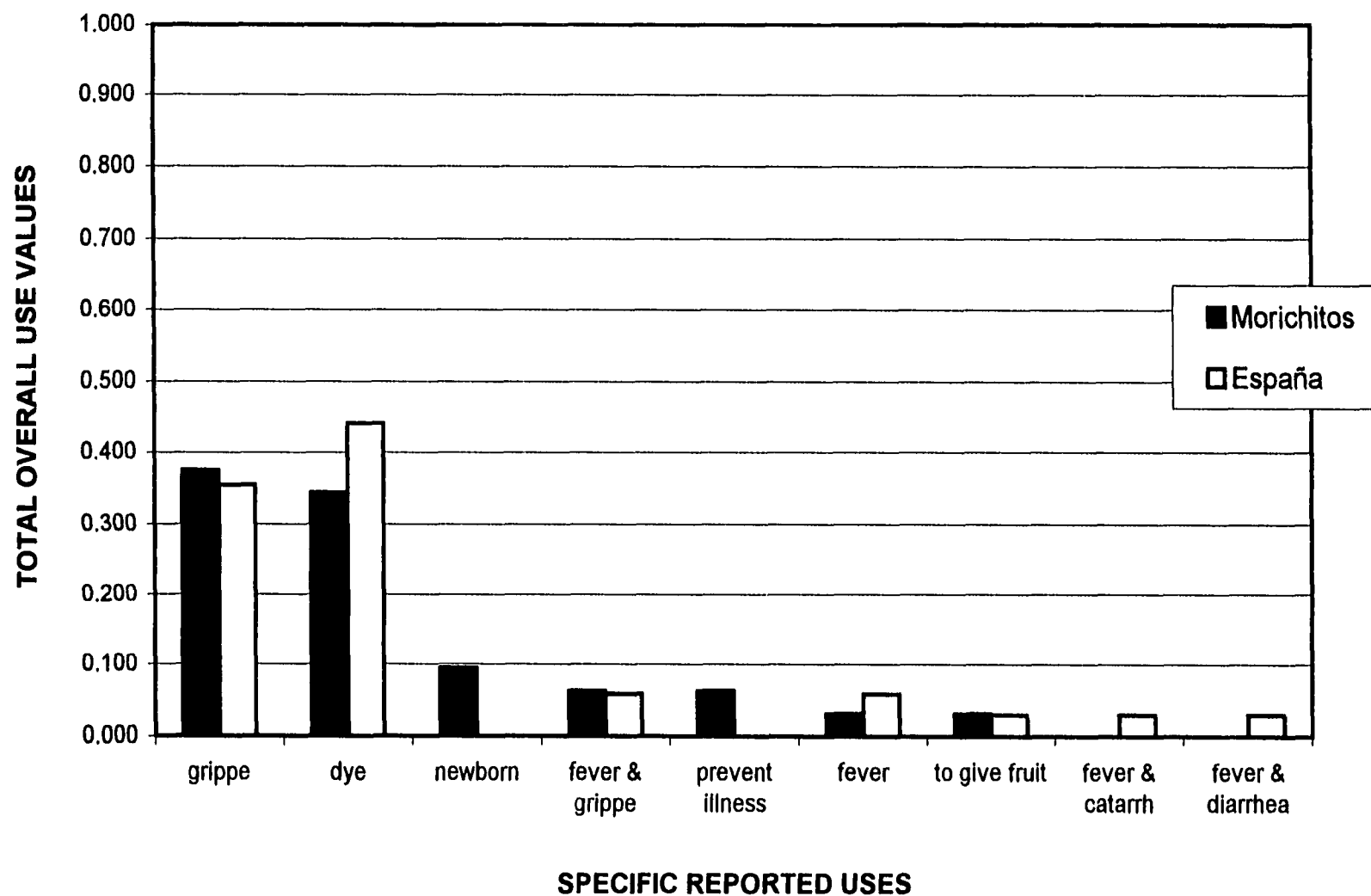
lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other

Table 5.46. Use values for *Murusi* (*Renealmia alpinia* (Rottb.) Maas.), village of España.

$\Sigma RU = 34$

ΣRU [plant part]	PPV	Specific Reported Use	SU	IUV	OUV
8 (lf)	0.235				
		grippe	4	0.500	0.119
		fever	1	0.125	0.029
		fever and grippe	1	0.125	0.029
		fever and diarrhea	1	0.125	0.029
		fever and catarrh	1	0.125	0.029
15 (fr)	0.441				
		dye	15	1.000	0.441
3 (fw)	0.088				
		grippe	2	0.667	0.059
		to give fruit	1	0.333	0.029
5 (bk)	0.147				
		grippe	4	0.800	0.118
		fever	1	0.200	0.029
3 (rt)	0.088				
		grippe	2	0.667	0.059
		fever and grippe	1	0.333	0.029
0 (ot)	0.000				
lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other					

Figure 5.22.
Comparison of Overall Use Values for Specific Reported Uses
for *Murusi* (*Renealmia alpinia* (Rottb.) Maas.).



D. Selection of *ohoru* (*Symphonia globulifera* L.f.)

There were nine (9) plants with Specific Reported Use as a treatment for "[non-venomous laceration] wounds" reported by the 40 respondents of the two villages. The plants were *mango*, *usiru*, *ohoru*, *korokororo*, *bihibihidu*, *iburu*, *samariya*, *anare*, and *ohidu*. All these plants were reported by Morichitos respondents but España respondents only reported wound healing use for *ohoru* and *samariya*. The Overall Use Value for "wound" was calculated by adding up all "wound" OUVs for both villages (Table 5.47).

Table 5.47. Calculation and ranking of Overall Use Values (OUV) for non-venomous laceration wound healing plants.

Plant Name	Calculation	Σ OUV
ohoru	$OUV_{[Morichitos, \textit{ohoru}, bark]} + OUV_{[Espan\tilde{a}, \textit{ohoru}, bark]}$ $= 0.545 + 0.308$	0.853
samariya	$OUV_{[Morichitos, \textit{samariya}, bark]} + OUV_{[Espan\tilde{a}, \textit{samariya}, bark]}$ $= 0.154 + 0.067$	0.221
mango	$OUV_{[Morichitos, \textit{mango}, leaf]} + OUV_{[Morichitos, \textit{mango}, bark]}$ $= 0.038 + 0.094$	0.132
bihibihidu	$OUV_{[Morichitos, \textit{bihibihidu}, bark]}$ $= 0.111$	0.111
iburu	$OUV_{[Morichitos, \textit{iburu}, bark]}$ $= 0.067$	0.067
anare	$OUV_{[Morichitos, \textit{anare}, bark]} =$ 0.064	0.064
korokororo	$OUV_{[Morichitos, \textit{korokororo}, fruit]}$ $= 0.053$	0.053
ohidu	$OUV_{[Morichitos, \textit{ohidu}, bark]}$ $= 0.037$	0.037
usiru	$OUV_{[Morichitos, \textit{usiru}, bark]}$ $= 0.031$	0.031

Based on these calculations, **ohoru** (*Symphonia globulifera* L.f.) has the highest Overall Use Value (0.853). The bark sap from this plant is reported to be used by the Winikina Warao for wound healing and was selected for testing wound healing activity using *in vivo* bioassays.

Chapter 6.

Bioassay Introduction

A. Wound Healing

Skin is a heterogeneous substance made up of “cells, a fibrous network composed of collagen and elastin, and an amorphous ground substance which consists of protein polysaccharides, glycoproteins, globular proteins, salts, and water” (Peacock, 1984, p. 102). The normal wound healing process involves a complex series of cascading events that includes a) coagulation, b) cellular migration and inflammation, c) proliferation of fibroblasts and collagen synthesis, and d) remodeling of the scar (Dunphy & Udupa, 1955; Mustoe, Pierce, Thomason, et al., 1987). Remodeling of the scar lasts several months while coagulation is immediate and collagen synthesis takes several days.

Collagen provides strength to the wound. Its formation is dependent on two factors, namely, 1) a protein component which passes through several stages before becoming collagen and 2) a carbohydrate component, a complex mucopolysaccharide necessary for the deposition of adult collagen. A lag phase, also known as the proliferative phase, takes place 3-6 days post-wounding and is the time when “wound debris must be disposed of, fibroblasts must be mobilized, and circulation must be restored” (Peacock, 1984, p. 105). The wound is most susceptible to infection at this time. Infection depends on amount of necrotic material in the wound and amount of trauma sustained by the

wound. Soon after the lag phase, collagen formation increases and reaches levels seen in normal skin by about day 14-21 when tensile strength is at its maximum. This is known as the period of fibroplasia (Peacock, 1984, p. 107).

Two types of measurements can be made for wound healing models—the tensile strength and the breaking strength. The tensile strength is “measured in terms of load applied per unit of cross section area...[and] is given as pounds per square inch or kilograms per square centimeter” (Peacock, 1984, p. 105). On the other hand, breaking strength is the “measurement of force required to break a wound without regard to its dimensions” (Peacock, 1984, p. 105). Wound healing is of the utmost importance to the medical profession, especially surgery. Because surgeons are interested in the disruption of skin, the breaking strength is the measurement of most interest to them (Mustoe, Pierce, Thomason, et al., 1987; Peacock, 1984, p. 106). Therefore, breaking strength, rather than tensile strength, will be measured for the wound healing bioassays carried out in this study.

A number of plants have been studied for their reported ethnobotanical use as treatments for wounds. These include *Aegle marmelos* Roxb. and *Moringa oleifera* Lam. (Udupa, Udupa, & Kulkarni, 1994a), *Aloe vera* L. (Heggers, Pelley, & Robson, 1993; Udupa, Udupa, & Kulkarni, 1994a; Heggers, Kucukcelebi, Stabenau, et al., 1995; Heggers, Kucukcelebi, Listengarten, et al., 1996), *Azadirachta indica* Juss. (Tandan, Gupta, Chandra, et al., 1995), *Ceropegia fusca* Bolle (Darias, Martin, Abdala, et al., 1996), *Croton lechleri* Muell.-Arg. (Pieters, De Bruyne, Van Poel, et al., 1995), *Leucas*

lavandulaefolia Rees. (Saha, Mukherjee, Das, et al., 1997), *Anredera diffusa* (R. et P.) Soukup, *Elentherine bulbosa* Mill., *Himatanthus sucuuba* Spruce (Muell.-Arg.) Woodson, *Jatropha curcas* L., *Mentzelia cordiflora* Dombey, *Muehlenbeckia tamnifolia* (HBK) Meisn., *Mutisia acuminata* R. et P. var. *acuminata* Cabrera, *Peperomia galioides* HBK, *Spondias mombin* L., (Villegas, Fernandez, Maldonado, et al., 1997), and *Wedelia calendulacea* Less. (Hedge, Khosa, & Chansouria, 1994).

Two plants which have been extensively investigated for their wound healing properties are *Aloe vera* L. (Heggers, Pelley, & Robson, 1993; Udupa, Udupa, Kulkarni, 1994b; Heggers, Kucukcelebi, Stabenau, et al., 1995; Heggers, Kucukcelebi, Listengarten, et al., 1996; Heggers, Elzaim, Garfield, et al., 1997) and *Croton lechleri* Muell.-Arg. (Vaisberg, Milla, Planas, et al., 1989; Pieters, De Bruyne, Mei, et al., 1992; Chen, Cai, & Phillipson, 1994; Pieters, De Bruyne, Van Poel, et al., 1995). Prior to studying their wound healing properties in the laboratory, both plants were first known for their ethnobotanical wound healing use.

Aloe vera L. and a variety of *Aloe* products have been tested for their efficacy in treating wounds caused by burns, frostbite, electrical injuries, and the acute inflammation caused by wounding. Clinical studies have also been carried out to measure the efficacy of an *Aloe vera* L. cream to treat burns, frostbite, and the site of entry of intravenous drug users. A comparison of the effects of pure *Aloe* with a variety of antimicrobial creams has also been carried out. In most of all these studies mentioned, wounds treated with *Aloe vera* L.

healed faster and better than the controls (Heggers, Pelley, & Robson, 1993; Udupa, Udupa, Kulkarni, 1994b; Heggers, Kucukcelebi, Stebenau, et al., 1995; Heggers, Kucukcelebi, Listengarten, et al., 1996; Heggers, Elzaim, Garfield, et al., 1997). It is speculated that the bioactivity of *Aloe vera* L. may be due to growth factors that are similar to those that contribute to wound healing (Heggers, Kucukcelebi, Stubenau, et al., 1995). Several growth factors, mainly growth factor- α , transforming growth factor- β , thrombin, platelet-derived growth factor and insulin-like growth factor-1, are implicated in enhancing wound healing (Carney, Mann, Redin, et al., 1992).

Croton lechleri Muell.-Arg., commonly known as *Sangre de Grado* or Dragon's Blood, has also been extensively studied for its cicatrizant properties because of its reported ethnobotanical use as a wound healing plant. Bioassays to test for the effects of *C. lechleri* sap on cell proliferation, toxicology, migration of human foreskin fibroblasts, fibroblast proliferation, thymidine incorporation, antibacterial activity and DNA synthesis of endothelial cells, have been carried out. Chemotaxis for fibroblasts and macrophages, a variety of neutrophil activity, and carcinogenic and tumor-promoting activity, has also been tested for this plant. A dose-response curve has been established for taspine hydrochloride, a compound isolated from *C. lechleri* sap (Vaisberg, Milla, Planas, et al., 1989; Porris-Reyes, Lewis, Roman, et al., 1993). Compounds isolated from this plant's sap include taspine, 3',4-O-dimethylcedrusin (lignan), polyphenolics (proanthocyanidins), thaliporphine and glaucine (aporphine alkaloids) (Bettolo, &

Scarpati, 1979; Vaisberg, Milla, Planas, et al., 1989, Pieters, De Bruyne, Mei, et al., 1992; Porras-Reyes, Lewis, Roman, et al., 1993).

For most plants with reported wound healing activity, especially those just mentioned, the linear incision wound healing model was an important measurement tool used to corroborate their reported ethnobotanical use. Linear incision wound healing models are used to measure wound healing activity because they “represent a true surgical wound that could be reproducibly analyzed in a non-subjective, highly controlled manner” (Mustoe, Pierce, Thomason, et al., 1987). Although quantitative differences in wound healing between animal species have been reported for linear incision wound healing bioassays, it has been established that rat skin behaves very much like human skin (Peacock, 1984, p. 105). As Peacock (p. 108) points out, “the absolute gain of strength in this early phase of wound healing [14-21 days post-wounding] is related to biochemical events occurring in the wound, which are the same in all tissues.” Consequently, rats are widely used for wound healing bioassays. Due to the vasoelastic structure of skin, any values given to its mechanical properties (in this case, breaking strength) depend on the site from where the information is obtained, the direction and application of force, and the rate of application of force (Peacock, 1984, p. 105). The linear incision wound healing model keeps these variables constant.

The single incision and the double incision wound healing models were used in this study to measure wound healing efficacy. The double incision wound healing model, using *Hamelia patens* Jacq., was used to establish a

wound healing bioassay protocol. Single incision and a double incision wound healing models were then used for two *ohoru* preparations (5% and 10% w/w) to measure whether it is an effective treatment for non-venomous wounds in a laboratory setting.

Chapter 7.
Double Incision Wound Healing Bioassay for
***Hamelia patens* Jacq.**

A. Introduction

Uncertainty on behalf of the *Ministerio del Ambiente y Recursos Naturales Renovables* (MARNR) as to how to enforce Venezuelan biodiversity and intellectual property rights laws prevented any biological material to be transferred outside that country. Therefore, I was limited to carrying out the questionnaire and bioassays in Venezuela during my tenure at the *Instituto Venezolano de Investigaciones Cientificas* (IVIC). In order to prepare myself for carrying out the bioassays at IVIC, a linear incision wound healing bioassay protocol was established and a preliminary bioassay was carried out in the U.S. using a plant with well known ethnobotanical wound healing use, *Hamelia patens* Jacq. This preliminary study is reported here.

Hamelia patens Jacq. is commonly used as a treatment for wounds in Central America, especially El Salvador, where the crude extract is blended into a soap and sold as a cleansing agent for wounds. Although its ethnobotanical use as a wound healing plant is well known (Ayala, 1994), there have been no studies that measure its reported wound healing ability using *in vivo* linear incision wound healing bioassays.

Hamelia patens Jacq., a member of the Rubiaceae plant family, is a bush or small tree, 1.4 to 3.0 m. tall with deeply veined leaves and red to bright orange-red, finely pubescent flowers. The subglobose to ellipsoid-shaped fruits mature to a black color (Arvigo & Balick, 1994; Weniger & Robineau, 1988). It is commonly known in El Salvador as *chichipince* but the plethora of common names which identify this species attests to its popularity and wide Neotropical distribution (Arvigo & Balick, 1994; Weniger & Robineau, 1988; Ayala, 1994; De Lezama, 1994; NAPRALERT, 1997).

B. Biological Activity and Isolated Compounds

Biological activity has been described for the dried leaf and stem extracts of *Hamelia patens*. Studies carried out in Cuba (Misas, Rosas-Hernandez, & Abraham, 1979) describe antibacterial activity against *Pseudomonas aeruginosa*, *Salmonella newport*, *Sarcina lutea*, *Serratia marcescens*, *Staphylococcus aureus* and *Escherichia coli* for the dried leaf ethanol extracts. The water extracts were active against *Salmonella B*, *Salmonella typhia*, *Sarcina lutea*, *Serratia marcescens*, *Shigella flexneri* and *Escherichia coli*. López-Abraham, Rojas-Hernandez, & Jimenez-Misas (1981), also of Cuba, describe antifungal activity against *Neurospora crassa* for the acetone, ethanol and water extracts of the dried leaves and stems of *H. patens*. Antidiarrheal and spasmolytic activity has been described from Mexico (Pérez, Zavala, Vargas, et al., 1996) for the dried leaf methanol extracts. In Panama, analgesic, diuretic, and hypothermic activity, as well as spontaneous activity stimulation, has been cited for the dried leaf methanol extracts (Esposito-Avella,

Brown, Tejeira, et al., 1985). A toxicity assessment in the same study yielded a LD₅₀ level of 1.54 g/kg intraperitoneal for the *Hamelia patens* methanol extract.

Joly, Guerra, Séptimo, et al. (1987) reported that in Panama an infusion of *Hamelia patens* stem bark is used to treat snake bites and to relieve post partum pain. In Guatemala, *H. patens* has been reported to treat fungal infections of the feet (Comerford, 1996) while in Haiti it is used as an abortive (Weniger, Haag-Berrurier, Anton, 1982). The leaves and roots of *H. patens* have also been reported from Honduras as a treatment for itching, skin infections, and inflammation (House, Lagos-Witte, Ochoa, et al., 1995, p. 210-211).

A variety of compounds have been isolated from *Hamelia patens*. Flavonoids have been isolated from the flowers, aerial parts, and leaves (Tiwari, Rathore, & Tripathi, 1978; Aquino, Ciavatta, De Simone, et al., 1990; Mahmood, Pizza, Aquino, et al., 1993). Alkaloids have been isolated from the aerial parts, leaves, roots, and the entire plant (Adams, Lee, & Mabry, 1989; Borges, Manresa, Martin-Ramon, et al., 1979; Borges Del Castillo, Manresa-Ferrero, Martin-Roman, et al., 1980; Borges Del Castillo, Manresa-Ferrero, Rodriguez-Luis, 1981; Borges Del Castillo, Manresa-Ferrero, Martin-Ramon, et al., 1982; Contreras, 1966; Robineau, 1989, p. 179-182). Isoquinoline alkaloids have been isolated from the leafs and twigs (Chaudhuri & Thakur, 1991), phenylpropanoids from the aerial parts (Aquino, Ciavatta, De Simone, et al., 1990), and saponins (Robineau, 1989, p. 179-182), steroids (Ripperger, 1977), and tannins (Robineau, 1989, p. 179-182) from the leaves.

C. Collection and identification of the Plant

Hamelia patens Jacq. was collected from the vicinity of Volcan de San Salvador, El Salvador, and was identified by Raúl Francisco Villacosta Munzón of the Escuela de Biología and Departamento de Química de la Universidad de El Salvador. The specimens were dried at room temperature and frozen at -30°C in San Salvador prior to shipment to avoid using pesticides. A voucher specimen is deposited in the National Herbarium of El Salvador.

D. Experimental Animals

Thirty-eight male Sprague-Dawley rats weighing 300-324 g each were used for this preliminary study. The rats were supplied by a commercial supplier. They were fed commercial rat feed and provided water *ad libitum*.

E. Extract and Ointment Preparation

The entire dried plant, including leaves, stems, and flowers, for a total of 394 g, was exhaustively extracted in 2 l ethanol. The mash was mixed every day for four days. The mixture was concentrated and dried under reduced pressure. The resultant ethanol-free crude extract was ready for use in the ointment preparation.

A 5% and 10% *Hamelia patens* w/w ointment was prepared from the plant extract using a petroleum jelly base. The 5% w/w ointment was prepared by mixing 15 g of crude *H. patens* extract with 285 g of petroleum jelly

for a total of 300 g. The 10% w/w ointment was prepared by mixing 30 g of *H. patens* extract with 270 g of petroleum jelly for a total of 300 g.

F. Method for double incision wound healing bioassay using *Hamelia patens*

The methodology for the double incision wound healing bioassay was based on the work of Saha, Mukherjee, Das, et al., (1997), Villegas, Fernandez, Maldonado, et al., (1997), Hedge, Khosa, and Chansouria (1994), Udupa, Udupa, and Kulkarni (1994a, 1994b), Porras-Reyes, Lewis, Roman, et al. (1993) and Mustoe Pierce, Thomason, et al. (1987). Table 7.1 presents a summary of the published *in vivo* linear incision wound healing bioassays that were used as a guide for designing the protocol for this study. The final protocol was submitted to and accepted by the Institutional Animal Care Use Committee of Lehman College-The City University of New York (Protocol No.: 98-9).

The rats were acclimated for 10 days in cages at the CUNY-Lehman College Animal Care Facility and fed water *ad libitum*. Eighteen hours prior to the incisions, the rats were fasted but given water *ad libitum*. Rats were anesthetized with pentobarbital (35 mg/kg intraperitoneal) and monitored for respiration, color, and temperature. After successful anesthesia, the back of each rat was depilated using a commercial barber's hair cutter. Two paravertebral incisions, 6 cm long, located 1.5 cm. from the midline on either side of the rat, were made through the skin and panniculus carnosus muscle to the deep fascia of each rat. The parted skin was coapted with three surgical clips

Table 7.1. Summary of *in vivo* linear incision wound healing bioassays used as guides for protocol preparation.

Authors (date)	Animal weight	Incision	Sutures	Application of Product	Measurement
Musto, Pierce, Thomason et al. (1987)	300-350 g	6 cm paravertebral	1.5 cm apart	Single application	Suture removed, breaking strength measured Day 7 and Day 14
Hedge, Khosa, and Chansouria (1994)	250-300 g	5.0 cm paravertebral	1.0 cm apart	Once daily	Sutures removed, wound area cut, breaking strength measured Day 8 and Day 12
Saha, Mukherjee, Das, et al. (1997)	150-180 g	Paravertebral-long	0.5 cm apart	Once daily	Breaking strength measured Day 9 (Note: Gives tensometer specifications used in dissertation project)
Udupa, Udupa, and Kulkarni (1994)	NS	6.0 cm	1.0 cm apart	Once daily, ip	Sutures removed Day 7 post-wounding and breaking strength measured Day 10
Villegas, Fernandez, Maldonado et al. (1997)	25-20 g	1.0 cm univertebral	Middle of incision	Suspension applied directly to wound every 12 hrs	After 48 hr, measure breaking strength
Porras-Reyes, Lewis, Roman, et al. (1993)	280-320 g	6.0 cm paravertebral	1.5 cm apart	Single application	Breaking strength measured Day 5, Day 7, and Day 12

NS = Not stated

placed 1.5 cm. apart and the wound left undressed. The rats were given butorphenol (4 mg/kg) post-op twice a day for two days to alleviate discomfort.

a. Administering the treatments

The rats were divided into three groups: 14, 14, and 10 rats for Group I, Group II, and Group III, respectively (Table 7.2). In Group I, the left wound was treated with 5% *Hamelia patens* and the contralateral side served as a control and received only petroleum jelly (PJ). Group II had the left wound treated with 10% ointment and the contralateral side with PJ. Group III had the left wound treated only with petroleum jelly ointment base and the contralateral side was left untreated. All treatments were applied once every 24 hours. Petroleum jelly (PJ) served as a positive control and the untreated wounds (NT) served as negative controls.

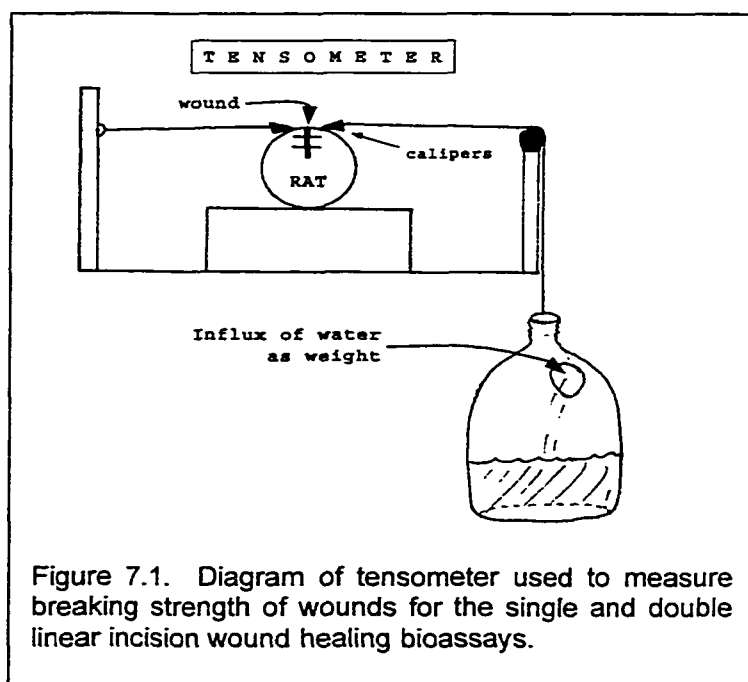
Table 7.2. Grouping of rats for the double incision wound healing bioassay using *Hamelia patens* Jacq. extract.

	Group I	Group II	Group III
Treatment	Left: 5% <i>Hp</i> Right: PJ	Left: 10% <i>Hp</i> Right: PJ	Left: PJ Right: NT
No. of Rats	14	14	10

Hp = *Hamelia patens*; PJ = petroleum jelly; NT = no treatment

b. Wound breaking strength

Because wound healing does not show any significant breaking strength until approximately after five days post-wounding (Dunphy & Udupa,



1955), half the rats of each of the groups were harvested on Day 7. The remaining half were harvested on Day 12. This is when collagen levels approximately reach normal skin collagen levels. For each harvest the rats were

ethanised individually using carbon monoxide narcosis followed by cervical dislocation to insure death. The staples were removed and wound breaking strength measured for each of the incisions using a tensometer built from the guidelines described in Saha, Mukherjee, Das, et al. (1997) (Figure 7.1).

Breaking strength of the wound was measured as the minimum force required to break apart the incision. The force, in Newtons (N), is calculated as mass (kg) times acceleration (9.8 m/s^2). Water and the dry weight of the container applied the force. Upon completion of each set of measurements, the animals were properly disposed.

c. *Hamelia patens* double Incision wound healing bioassay results

The data analysis was carried out using the SPSS statistical software package. Comparisons of groups of means were carried out using paired sample t-tests and considered significant at $p < 0.05$ and highly significant at $p < 0.01$.

The first analysis was to determine if there was a significant difference in wound healing between Day 7 and Day 12 post-wounding for the treated wounds (Table 7.3, Figure 7.2).

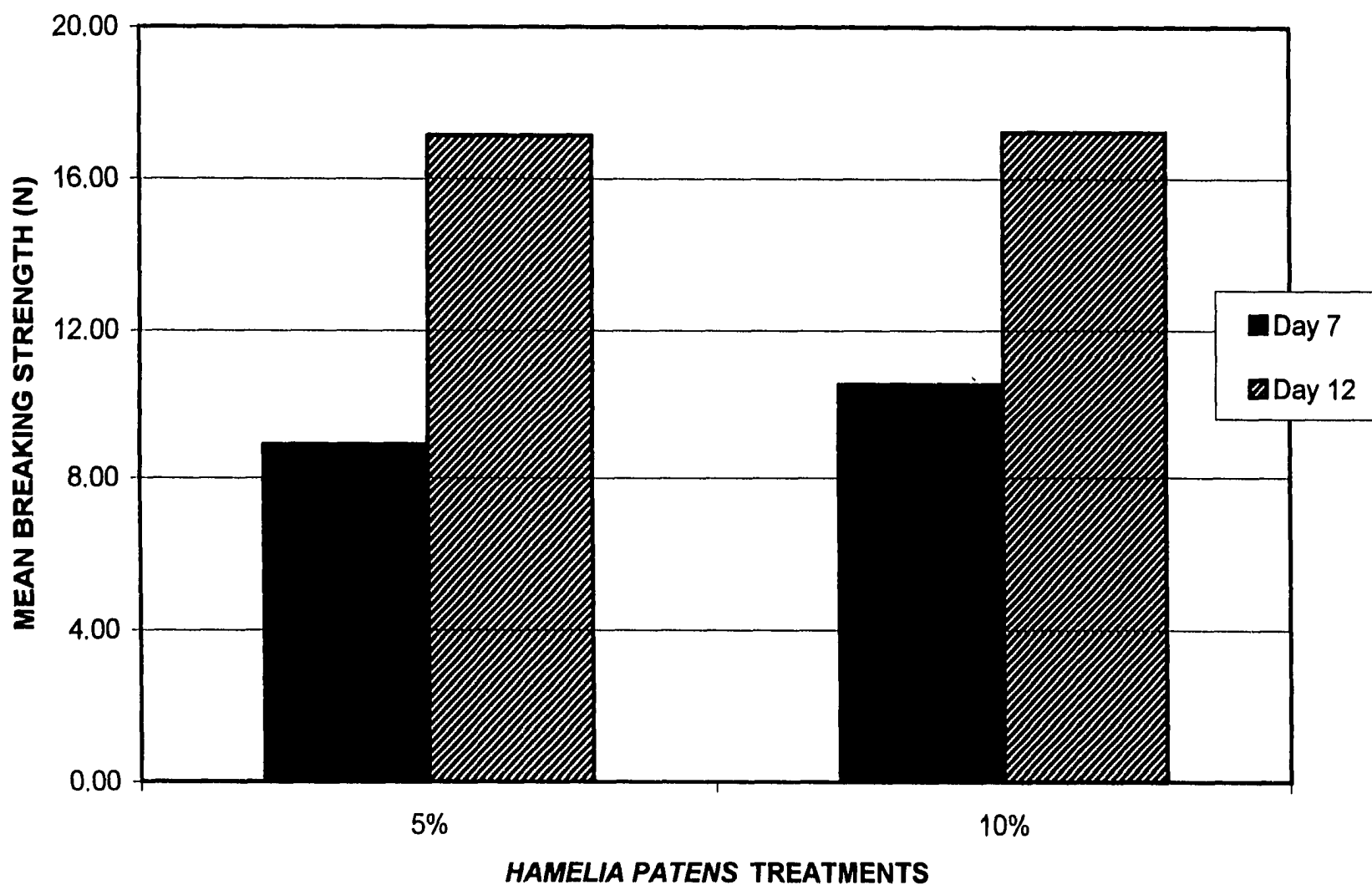
Table 7.3. Comparison of mean breaking strength between Day 7 and Day 12 post-wounding for 5% and 10% *Hamelia patens* Jacq. treatments using the double incision wound healing bioassay.

Comparison	Breaking Strength Means (kg·m/s ²)	Signif.
Day 7 Group I (5% w/w)	8.90	**
and		
Day 12 Group I (5% w/w)	17.13	
Day 7 Group II (10% w/w)	10.55	**
and		
Day 12 Group II (10% w/w)	17.22	

** = ($p < 0.01$)

Figure 7.2.

Mean breaking strengths at 7 and 12 days post-wounding for 5% w/w and 10% w/w *Hamelia patens* Jacq. treatments using the double incision wound healing bioassay.



The second analysis was to determine if there was a difference in wound healing for treated and control sides (Table 7.3, Figure 7.3 and 7.4).

Table 7.4. Comparison of breaking strength between treatments and controls for *Hamelia patens* using the double incision wound healing bioassay.

Comparison	Breaking Strength Means (kg·m/s ²)	Signif.
Day 7 Group I (5% w/w) and Day 7 Group I (PJ)	8.90 8.71	ns
Day 12 Group I (5% w/w) and Day 12 Group I (PJ)	17.13 15.23	*
Day 7 Group II (10% w/w) and Day 7 Group II (PJ)	10.55 9.85	ns
Day 12 Group II (10%) and Day 12 Group II (PJ)	17.22 15.01	*

* = $p < 0.05$; ns = no significant difference

Figure 7.3.

Comparison of breaking strength means between 5% w/w *Hamelia patens* Jacq. treatment and control (petroleum jelly) using the double incision wound healing bioassay.

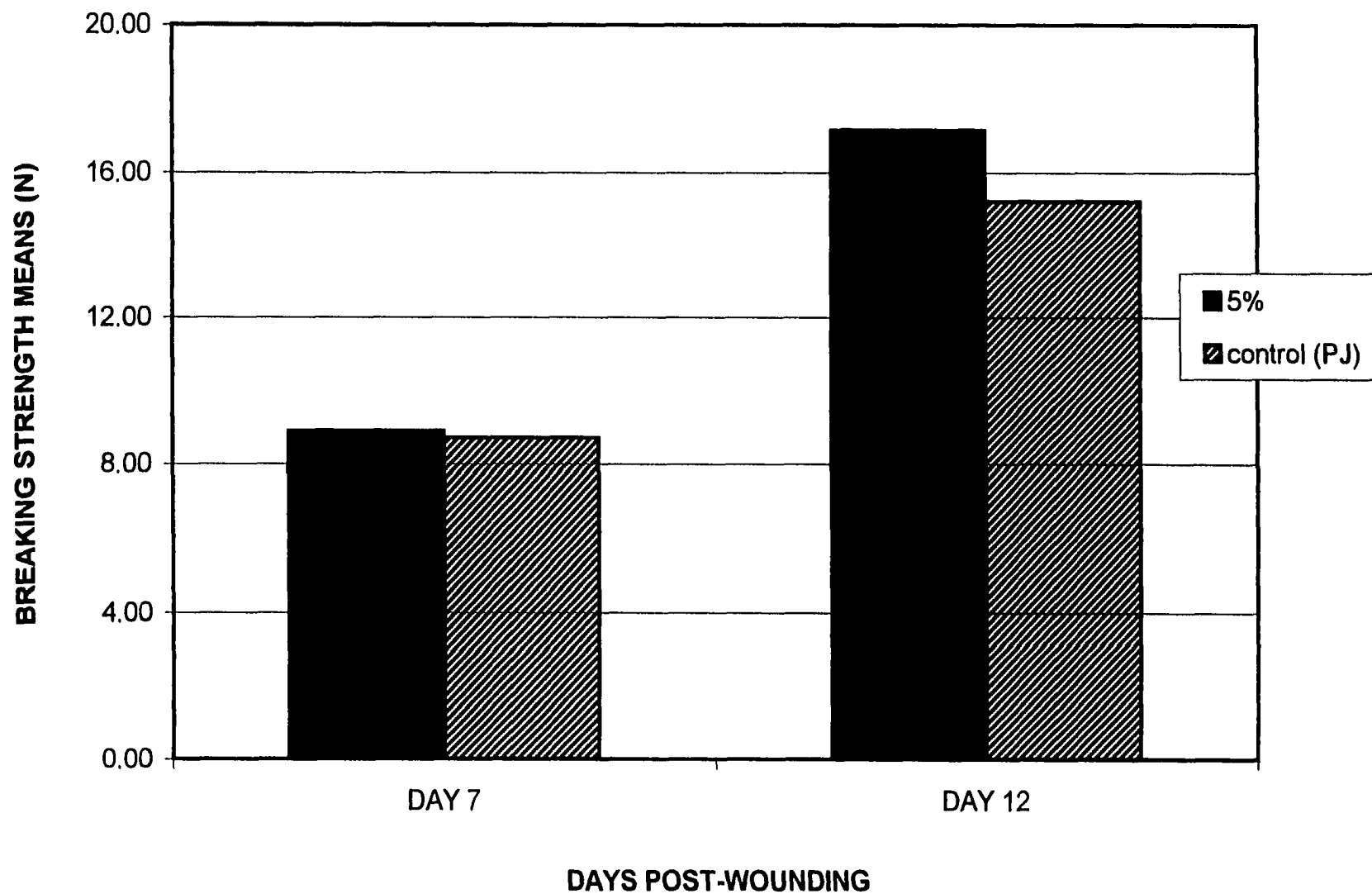
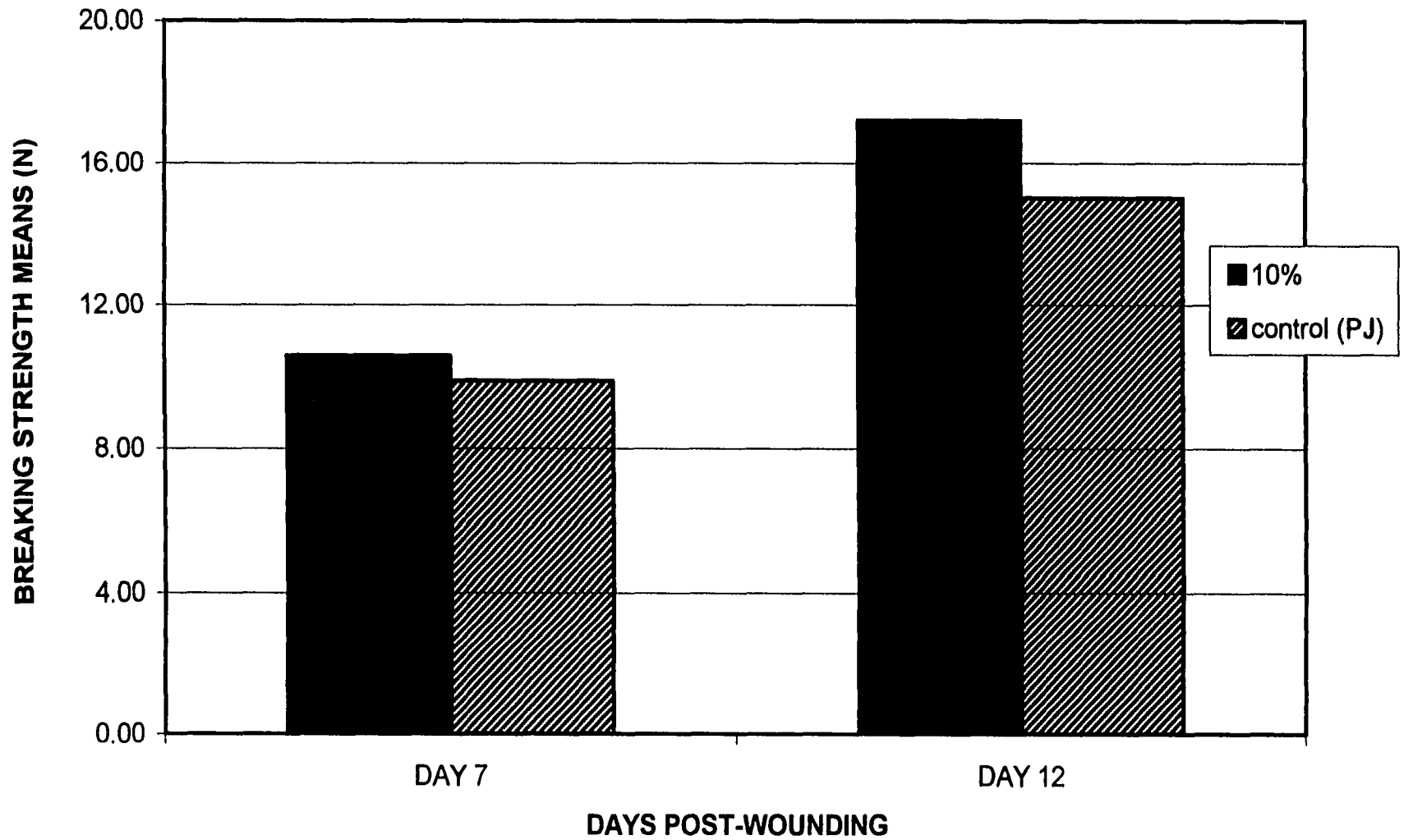


Figure 7.4.

Comparison of breaking strength means between 10% w/w *Hamelia patens* Jacq. treatment and control (petroleum jelly) using the double incision wound healing bioassay.



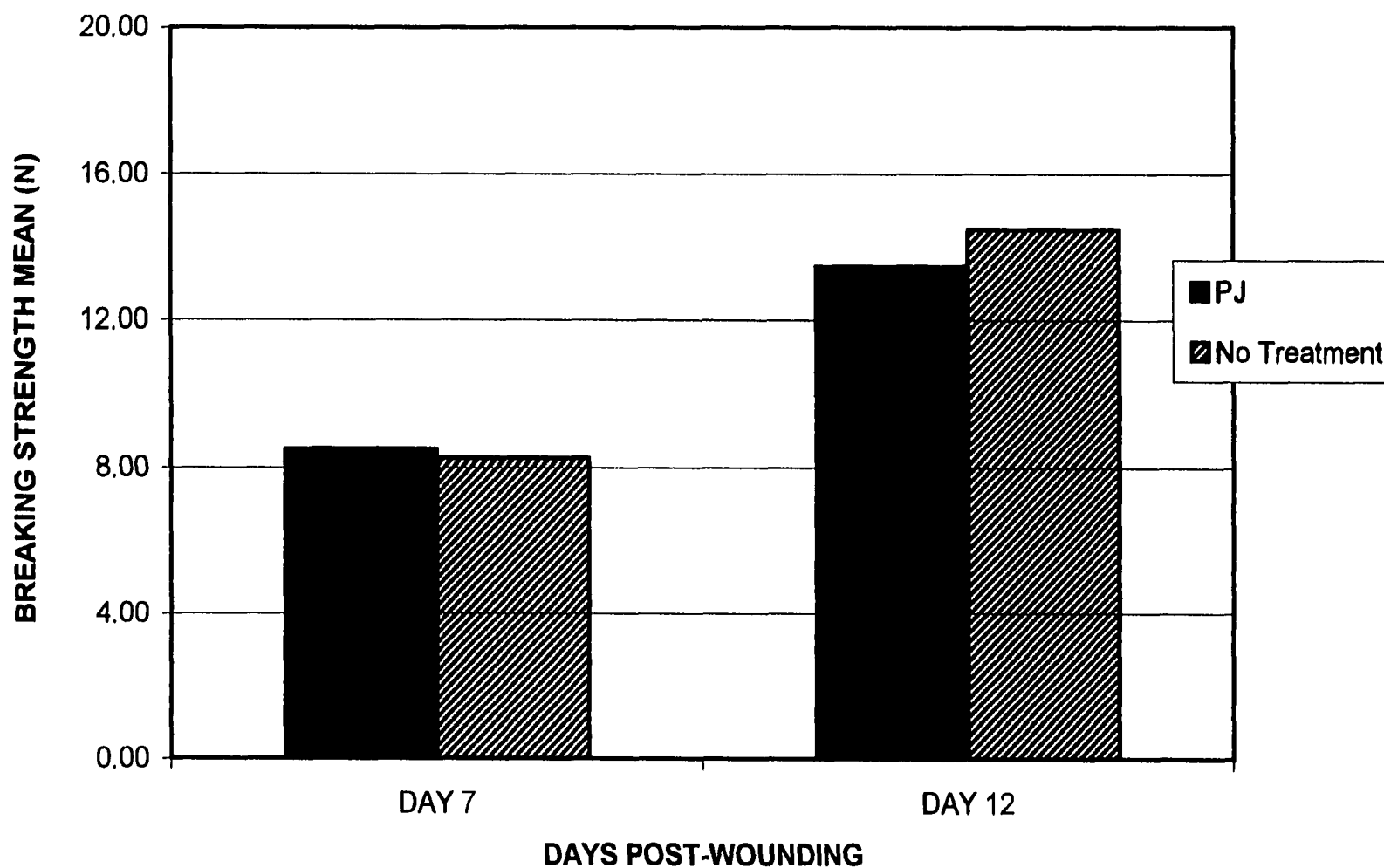
In order to determine if petroleum jelly had any effect on wound healing, a comparison was made with the control group (Group III) between petroleum jelly and non-treated sides (Table 7.4, Figure 7.5).

Table 7.5. Comparison of breaking strength between Group III controls using the double incision wound healing bioassay.

Comparison	Mean Newtons (kg·m/s²)	Signif.
Day 7 Group III (PJ) and Day 7 Group III (no treatment)	8.52 8.26	ns
Day 12 Group III (PJ) and Day 12 Group III (no treatment)	13.45 14.46	ns

* = $p < 0.05$; ns = no significant difference

Figure 7.5.
Comparison of breaking strength means between wounds treated with petroleum jelly and those receiving no treatment using the *Hamelia patens* Jacq. double incision wound healing bioassay.



d. *Hamelia patens* double Incision wound healing bioassay discussion

The primary purpose of carrying out the double incision wound healing bioassay with *Hamelia patens* Jacq. was to establish a protocol for wound healing bioassays and to practice the bioassay before I left for Venezuela. The other purpose was to analyze wound healing activity of *Hamelia patens* based on the double incision wound healing model.

The first analysis revealed that there was a statistically significant different ($p < 0.01$) in breaking strength between Day 7 and Day 12 for both the 5% and 10% w/w treatments (Table 7.2, Figure 7.2). This indicates that wound healing is occurring at a normal rate for the treated wounds.

The second analysis (Table 7.3, Figure 7.3 and 7.4), comparison of breaking strength between treatment and control wounds, revealed that at Day 7, there was no statistically significant difference in breaking strength. However, at Day 12, there was a significant difference between the wound treated with 5% w/w *Hamelia patens* and the control wound and the wound treated with 10% w/w *Hamelia patens* and the control wound. These results indicate that wound healing is approximately the same between the treatment and control at Day 7 but at Day 12, the treated sides are stronger than the control sides. Thus, *Hamelia patens* treatment does increase wound breaking strength when compared to a control group.

Finally, a comparison between the wounds of the control group revealed that there was no significant difference at Day 7 and Day 12 between

the control groups but the increase in breaking strength from Day 7 to Day 12 indicates that normal wound healing is occurring.

Hamelia patens Jacq. is widely used in Latin America, especially El Salvador, as a wound healing plants. These results corroborate its ethnobotanical use for the same. Thus, the protocol for wound healing bioassays was established and ready to be used for the plant with highest Overall Use Value for wound healing as reported by the Winikina Warao.

Chapter 8.

Single and Double Incision Wound Healing Bioassays for *Ohoru* (*Symphonia globulifera* L.f.)

A. Introduction

The bright yellow sap from *Symphonia globulifera* L.f. (Clusiaceae), called **ohoru** by the Winikina Warao of the lower Orinoco River Delta, is used by them as a treatment for non-venomous laceration wounds. Of the 40 Winikina Warao respondents that were surveyed in the two Winikina villages, Morichitos and España, 11 (28%) respondents reported **ohoru** bark sap as a treatment for non-venomous laceration wounds. Almost all of these respondents reported the same method of use for **ohoru** (Table 8.1).

Symphonia globulifera L.f. is a tree found throughout the tropics of America, Africa and Madagascar. In Venezuela, it is found in the states of Bolívar, Amazonas, Anzoátegui, Apure, Monagas, Sucre, and is dominant in the Orinoco River Delta swamps of Delta Amacuro (Kearns, 1998, p. 311). Although it is known to vary in size, texture, form of leaves, size of flowers and inflorescence (Kearns, 1998, p. 312), in the Orinoco River Delta it is highly noticeable by the bright red fruits which contrast with its bright green leaves (W. Wilbert, 1986; personal field notes). Another defining characteristic of this tree, and this plant family in general, is the bright yellow sap which flows from the cortex (Kearns, 1998, p. 311).

Table 8.1. Specific Use Reports for *ohoru* (*Symphonia globulifera* L.f.) from the villages of Morichitos and España.

<i>Morichitos</i>	
Plant Part Used	Use
bark	Scrape bark, squeeze juice onto cut.
bark	From sunny side of bark, cut finger-length wide piece, boil, cool, put liquid on cut.
bark	For machete wound; use bark sap to cover wound.
bark	For a cut; scrape bark, get sap, place on bleeding cut.
bark	Put a thin layer of sap on cut to stop bleeding.
bark	For axe or machete cut; cut bark, get sap, place on wound.
<i>España</i>	
Plant Part Used	Use
root	For cut to stop bleeding; scrape bark, put on bleeding wound.
bark	Scrape bark, put shavings on wound to stop bleeding.
bark	Use bark sap to stop bleeding.
bark	For wound/cut; cut bark, get sap, place on cut.
bark	For wound; slash bark, get resin, place on wound to stop bleeding.

B. Biological Activity and Isolated Compounds

Symphonia globulifera L.f. has been used as a treatment for scabies in Gabon, Africa (Akendengue & Louis, 1994). In Panama, the stem is used to treat bloody vomiting (Joly, Guerra, Séptimo, et al., 1987). To date only flavanoids (Guttiferone A, B, C, and D) have been isolated from the roots of *S. globulifera* collected from the Ndakan Gorilla Study Area in the Central African Republic (Gustafson, Blunt, Munro, et al., 1992). These guttiferones are polyisoprenylated benzophenone derivatives, compounds which have been

shown to inhibit the Human Immunodeficiency Virus in *in vitro* studies (Gustafson, Blunt, Munro, et al., 1992). Kearns (1998) states that among the Guayana region Indians the sap is used as a wax for tool manufacture and maintenance, as a caulk for canoes, an all-purpose glue, and as source of light (p. 312).

C. Collection and Identification of the Plant

Werner Wilbert, in his dissertation, *Warao Herbal Medicine: A Pneumatic Theory of Illness* (1986), was the first non-Warao to describe, in detail, the use of **ohoru** from *Symphonia globulifera* as a treatment for non-venomous laceration wounds by the Warao. During my preliminary field trips to the Winikina region of the Orinoco River Delta and by talking with the Winikina Warao, I was able to corroborate the use of this plant as a treatment for wounds, as well as corroborate the uses of many other plants described as Warao phytomedicines (Beloz, 1992).

I identified and verified, with the help of Warao collaborators, all 18 species of plants used in the questionnaire. Plants used in the questionnaire were selected after a thorough review of the Warao literature, the work of Wilbert (1986), and my own field work. The plants were selected for their well known use by the Winikina Warao. Also, they were selected because they had only one common Warao name associated with that particular species. In other words, there was only one **mango**, one **idu**, one **korokororo**, **ohoru**, etc. W. Wilbert, who has spent over 20 years working with the Winikina Warao, maintains that

"previous field experience had taught me that the Warao do not apply the same name to more than one species" (Wilbert, 1994-96).

Because I was not able to receive a voucher collection permit from the Venezuelan *Ministerio del Ambiente y Recursos Naturales y Renovables* (Ministry of the Environment and Natural and Renewable Resources) in time for this project, I was not able to deposit my own voucher specimen of *Symphonia globulifera* in any herbarium. However, I verified the identification of **ohoru** by comparing my field notes with the notes on deposited voucher specimens collected by W. Wilbert. I also identified the tell-tale physical features of a live specimen (yellow bark sap, bright red fruits), and had two Warao plant experts identify it. I looked over the vouchers collected by Dr. Werner Wilbert deposited in the *Herbario Ovalles* (MYF) of the *Universidad Central de Venezuela*. Voucher MYF#68320 (W. Wilbert) was used to verify **ohoru** as *Symphonia globulifera*. Using these verification methods, I was certain that **ohoru** I collected was *Symphonia globulifera* L.f.

As an enrolled graduate student of the *Instituto Venezolano de Investigaciones Cientificas* (IVIC), I was able to collect only the **ohoru** bark sap for laboratory analysis at IVIC. All laboratory tests were carried out in the *Centro de Biofísica y Bioquímica, Laboratorio de Fisiología Gastrointestinal*. Protocols were submitted to the IVIC Animal Care and Husbandry Facility (ACHF) manager. The project protocol was approved by IVIC investigator, Dr. Fabian Michelangeli, who was also my Venezuelan mentor. A letter (Appendix G) was presented to Dr. Jim Miller of the Missouri Botanical Garden for verification of

acceptance of the project bioassay protocols by IVIC-ACHF. Though the letter was not necessary, it does demonstrate that my project protocols were approved by the IVIC-ACHF.

D. Experimental Animals

A total of 50 Sprague-Dawley rats, 150-200 g, were used for both bioassays. Twenty-six (26) were used for the single incision wound healing bioassay and 24 were used for the double incision wound healing bioassay. The rats were ordered from the IVIC Animal Care and Husbandry Facility and sent to the *Centro de Biofísica y Bioquímica* animal laboratory. They were acclimated for 3 days, fed commercial rat feed and given water *ad libitum*. Due to the limited space in the animal care facility in the *Centro de Biofísica y Bioquímica*, the maximum number of rats that could be housed for a study at any one time was 30.

E. Extract and Ointment Preparation

After the 40 respondents were interviewed and **ohoru** (*Symphonia globulifera* L.f.) identified as the plant with highest Overall Use Value for treating wounds, I collected the bright yellow sap from the cortex of **ohoru** trees found in the forest on the western side of the Winikina River in the area between the two villages under study. In this undisturbed forest, along a smaller branch of the Winikina River, a cluster of **ohoru** trees was identified by my Warao collaborator, Tirzo Rivero and myself. The bark of these trees was slashed with a machete

(Figure 8.1). The sap was immediately collected into small vials and sealed to prevent oxidation, which leads to hardening of the sap.

Based on my experience with *Hamelia patens* as presented earlier,

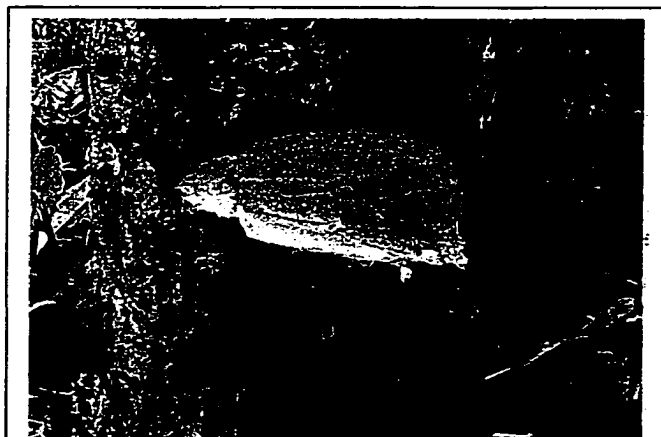


Figure 8.1. A *Symphonia globulifera* trunk slashed for procuring **ohoru** sap. The **ohoru** sap flows from the cortex layer.

I wanted to mix **ohoru** sap with petroleum jelly so that it could be easily applied to the wounds of the animals for the bioassays.

However, **ohoru** would not readily blend with petroleum jelly.

Attempts were made to

solubalize **ohoru** with solvents of different polarities to find one that

would blend with petroleum jelly. These solvents included water, methanol, ethanol, and chloroform. None of these was able to solubalize **ohoru**. Based on findings from the wound healing studies done with *taspine* (Porrás-Reyes, Lewis, Roman, et al., 1993), a bark sap from *Croton lechleri* Muell.-Arg. (see Chapter 7), I decided to try dimethyl sulfoxide (DMSO) as a solvent. Dimethyl sulfoxide stabilized **ohoru** so it would not readily oxidize and made it soluble enough to mix with petroleum jelly. Dimethyl sulfoxide has been shown to have little effect on wound healing when compared with wounds treated with water and untreated wounds (Goldblum, Alvarez, Meitz, et al., 1983).

The correct ratio of **ohoru** to dimethylsulfoxide was established at 1 g **ohoru** per 1 ml DMSO. A mixture of **ohoru**:DMSO, based on this ratio, was

used for the treatment preparations. The **ohoru**:DMSO mixture was combined with petroleum jelly to make 5% and 10% w/w ointments (Table 8.2). A sufficient amount of extract was made in anticipation of the two bioassays. The treatment material and raw **ohoru** latex was stored in a -10° C freezer when not in use.

Table 8.2. Composition of 5% and 10% w/w *ohoru* (*Symphonia globulifera* L.f.) treatments.

Treatment	Composition
5% ohoru	[5 g ohoru + 5 ml DMSO] + [90g petroleum jelly]
10% ohoru	[10 g ohoru + 10 ml DMSO] + [80 g petroleum jelly]

F. Single Incision Wound Healing Bioassay Using *Ohoru* (*Symphonia globulifera* L.f.)

The single incision wound healing bioassay was used prior to the double incision wound healing bioassay in order to determine if **ohoru** would affect normal wound healing. Eighteen hours prior to incisions, rats were fasted but given water *ad libitum*. Rats were anesthetized with Rompún® (zylazine) (5 mg/kg intraperitoneal) plus ketamine hydrochloride (40 mg/kg body weight intraperitoneal) and monitored for respiration, color, and temperature.

After successful anesthesia, the back of each rat was depilated. One paravertebral incision 4 cm in length located 1.5 cm. from the midline on the right side of each rat was made through the skin and panniculus carnosus muscle to the deep fascia. Three intermittent sutures were placed 1 cm apart to secure the edges of the wound.

a. Administering the treatments

The rats were divided into four groups: 9, 9, 4, and 4 rats for Group I, Group II, Group III, and Group IV, respectively (Table 8.3). Group I wounds received 5% *ohoru* treatment. Group II wounds were treated with 10% *ohoru*. Group III wounds received DMSO and petroleum jelly (PJ) ointment base (5 ml DMSO + 95 g petroleum jelly) and served as a positive control. Group IV received only petroleum jelly (negative control). All treatments were applied once every 24 hours.

Table 8.3. Grouping of rats for the single incision wound healing bioassay using *ohoru* (*Symphonia globulifera* L.f.) extract.

	Group I	Group II	Group III	Group IV
Treatment	5% <i>ohoru</i>	10% <i>ohoru</i>	DMSO + PJ	PJ
No. of Rats	9	9	4	4

To relieve post-operative pain and distress, the pain reliever Novalcina® (0.1 mg/kg body weight intramuscular) was given twice a day for two (2) days. The rats were fed commercial rat feed and given water *ad libitum* throughout the remainder of the bioassay.

b. Wound breaking strength

Half the rats of each group were harvested on Day 7. The remaining half were harvested on Day 12. For each harvest the rats were euthanised individually using chloroform narcosis followed by cervical dislocation to insure death. The stitches were removed and wound breaking strength measured for each of the incisions using a tensometer (see Figure 7.1). Breaking strength

of the wound was measured as the minimum force required to split apart the wound incision. The force, in Newtons (N), is calculated as mass (kg) times acceleration (9.8 m/s^2). Water and the dry weight of the container applied the force. Upon completion of each set of measurements, the animals were properly disposed.

G. Single Incision Wound Healing Bioassay Results for *Ohoru* (*Symphonia globulifera* L.f.)

Data analysis was carried out using the SPSS statistical software package. Comparisons of groups of means were carried out using paired sample t-tests and considered significant at $p < 0.05$ and highly significant at $p < 0.01$.

The single incision bioassay was used to determine if there was a significant difference in wound healing between Day 7 and Day 12 post-wounding (Table 8.4, Figure 8.2).

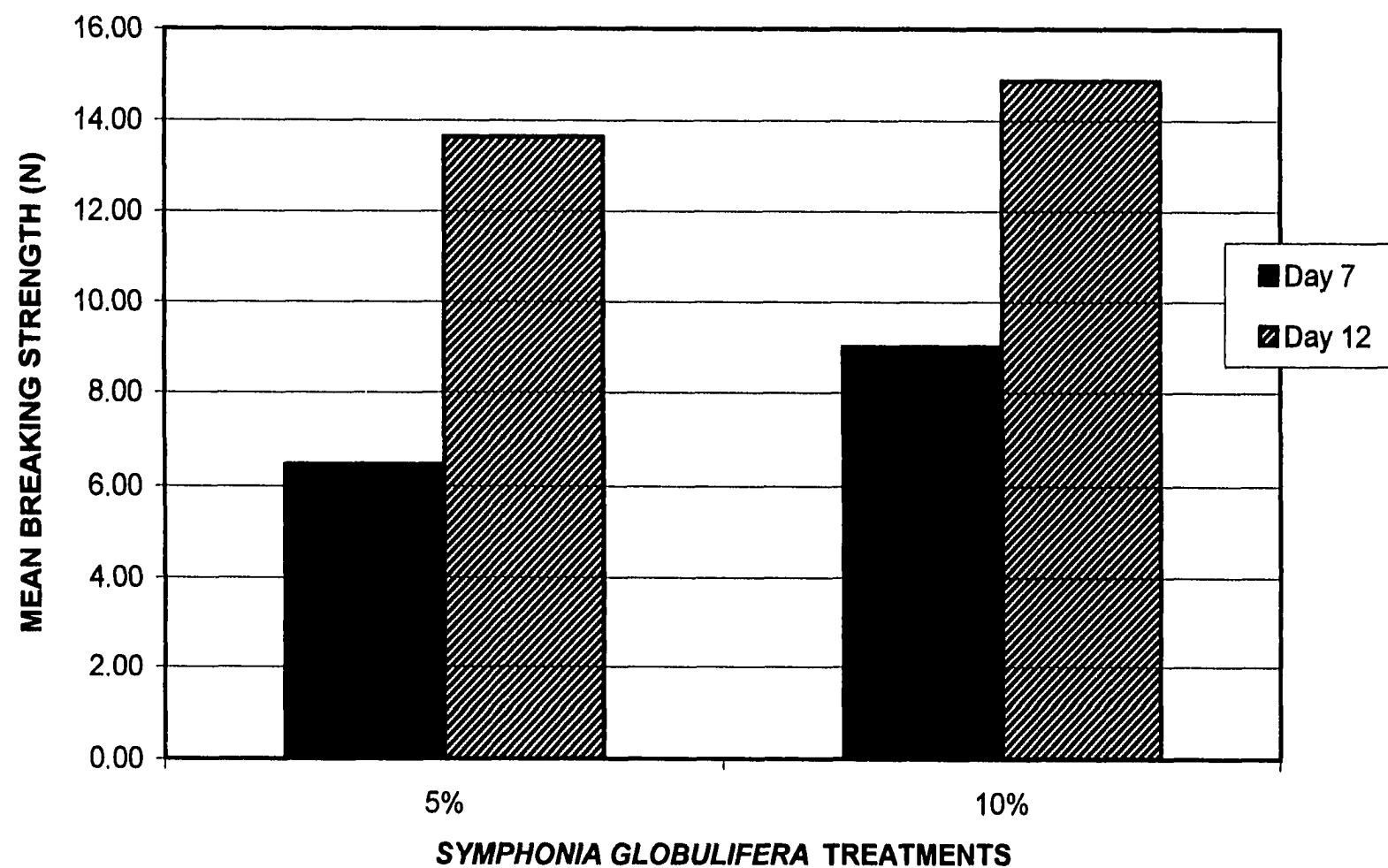
Table 8.4. Comparison of breaking strength between Day 7 and Day 12 post-wounding for 5% w/w and 10% w/w *ohoru* (*Symphonia globulifera* L.f.) treatments using the single incision wound healing bioassay.

Comparison	Breaking Strength Means (kg·m/s²)	Signif.
Day 7 Group I (5% w/w)	6.46	
and		**
Day 12 Group I (5% w/w)	13.63	
Day 7 Group II (10% w/w)	8.99	
and		**
Day 12 Group II (10% w/w)	14.86	

**** = $p < 0.01$**

Figure 8.2.

Mean breaking strengths at 7 and 12 days post-wounding for 5% w/w and 10% w/w *Symphonia globulifera* L.f. treatments using the single incision wound healing bioassay.



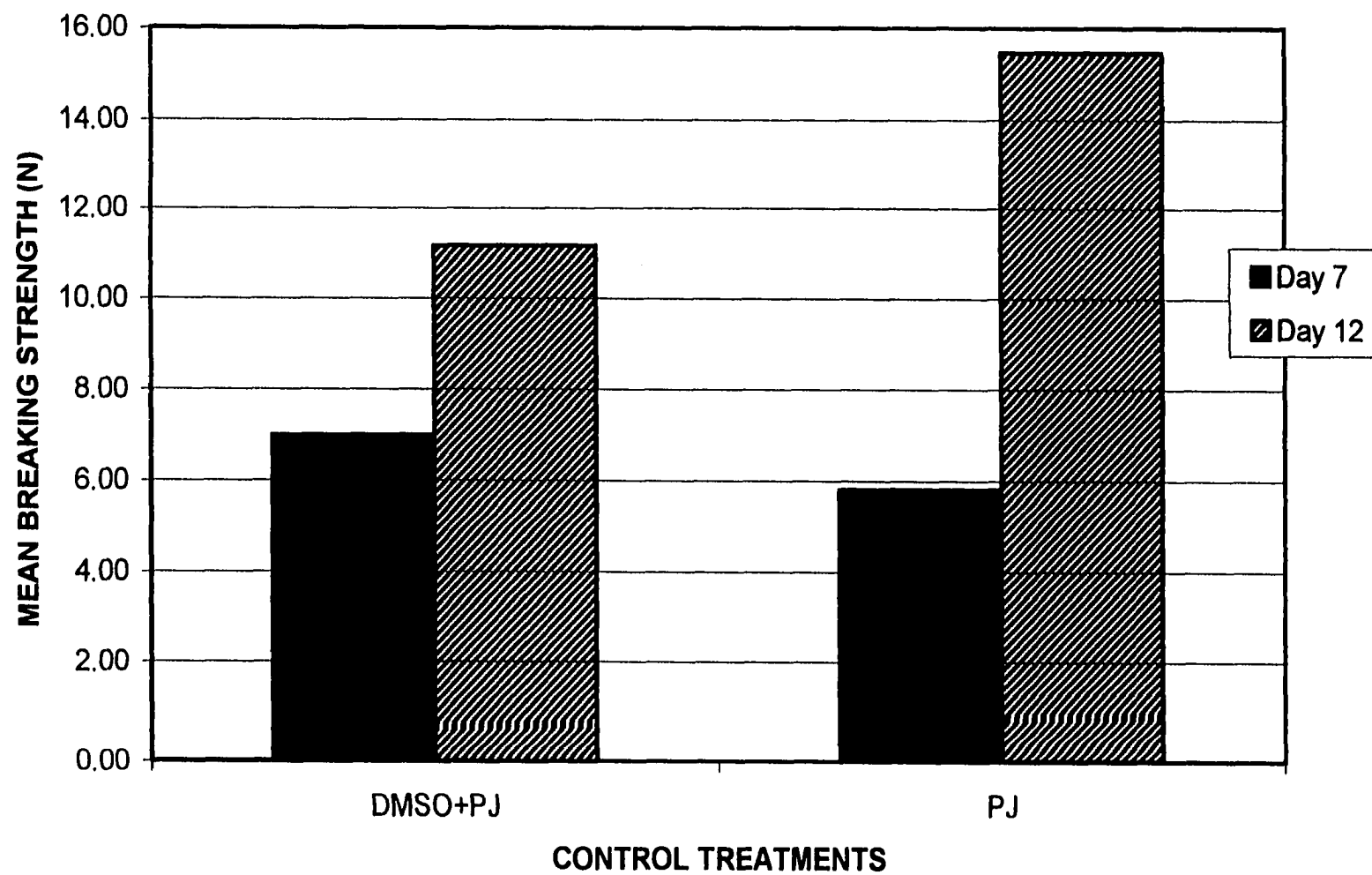
The next analysis was carried out of the control group to determine if the DMSO+PJ vehicle was significantly different from petroleum jelly (Table 8.5, Figure 8.3).

Table 8.5 Comparison of breaking strength between controls using the single incision wound healing bioassay.

Comparison	Breaking Strength Means (kg·m/s²)	Signif.
Day 7 Group III (DMSO + PJ) and Day 12 Group III (DMSO + PJ)	6.99 11.15	ns
Day 7 Group IV (PJ) and Day 12 Group IV (PJ)	5.80 15.46	**

** = $p < 0.01$; ns = not significant

Figure 8.3.
Mean breaking strengths at 7 and 12 days post-wounding for DMSO+PJ and PJ controls
using the *Symphonia globulifera* L.f. single incision wound healing bioassay.



H. Discussion for Single Incision Wound Healing Bioassay Using *Ohoru* (*Symphonia globulifera* L.f.)

The results in Table 8.4, Figure 8.2, demonstrate that there is a significant difference in breaking strength from Day 7 to Day 12 for wounds treated with both 5% and 10% w/w *ohoru*. Thus, normal wound healing is occurring.

A look at the two control groups (Table 8.5, Figure 8.3), shows that there is no significant increase in breaking strength between those wounds treated with DMSO+PJ. However, there is a significant difference from Day 7 to Day 12 for the PJ control group. These control group results suggest that DMSO may affect breaking strength. However, Gries (1971) points out that DMSO had “no remarkable effect...on the newly synthesized collagen and scar repair” for the wound healing experiments he used. The control group results may be due to experimental error or the small number of rats available for analysis of the control group. Nevertheless, the treated wounds do demonstrate that wound healing activity is taking place.

The next step was to carry out the double incision wound healing bioassay to measure if there was any difference in wound healing between treatment and control wounds within each treatment group.

I. **Double Incision Wound Healing Bioassay Using *Ohoru* (*Symphonia globulifera* L.f.)**

Twenty-four (24) rats (Sprague-Dawley, 150-200 g) were ordered from the Animal Care and Husbandry Facility and delivered to the *Centro de Biofísica y Bioquímica* animal laboratory. They were acclimated for 3 days, fed commercial rat feed and given water *ad libitum*. Eighteen hours prior to incisions, rats were fasted but given water *ad libitum*. Rats were anesthetized as was done for the single incision wound healing bioassay.

After successful anesthesia, the back of each rat was depilated. Two paravertebral incisions of 4 cm in length located 1.5 cm. from the midline on each side of the rat were made through the skin and panniculus carnosus muscle to the deep fascia of each rat. Three intermittent sutures were placed 1 cm apart to secure the edges of each of the wounds.

a. Administering the treatments

The rats were divided into three groups with 8 rats in each of the three groups (Table 8.6). For Group I, the left incision received 5% w/w ***ohoru*** treatment and the right incision served as control (DMSO+petroleum jelly). In Group II, the left incision received 10% w/w ***ohoru*** treatment and the right incision served as control (DMSO+petroleum jelly). For Group III, the Control Group, the left incision was treated with DMSO+petroleum jelly (positive control) and the right side received no treatment (negative control).

Table 8.6. Grouping of rats for the double incision wound healing bioassay using *ohoru* (*Symphonia globulifera* L.f.) extract.

	Group I	Group II	Group III
Treatment	Left: 5% <i>ohoru</i> Right: DMSO+PJ	Left: 10% <i>ohoru</i> Right: DMSO+PJ	Left: DMSO+PJ Right: no treatment
No. of Rats	8	8	8

To relieve post-operative pain and distress, the pain reliever Novalcina® (0.1 mg/kg body weight intramuscular) was given for two (2) days, twice a day. The rats were treated once a day until harvest. The rats were fed commercial rat feed and given water *ad libitum* for the remainder of the study.

b. Wound breaking strength

Half of the rats of each group were harvested on Day 7 and the remaining half were harvested on Day 12. For each harvest, the rats were euthanised individually using chloroform narcosis followed by cervical dislocation to insure death. The sutures were removed and wound breaking strength measured for each of the incisions using the same tensometer built for the single incision wound healing bioassay. Breaking strength of the wound was measured as was done for the previous bioassays.

J. Double Incision Wound Healing Bioassay Results for *Ohoru* (*Symphonia globulifera* L.f.)

Data analysis was carried out using the SPSS statistical software package. Comparisons of groups of means were carried out using paired

sample t-tests and considered significant at $p < 0.05$ and highly significant at $p < 0.01$.

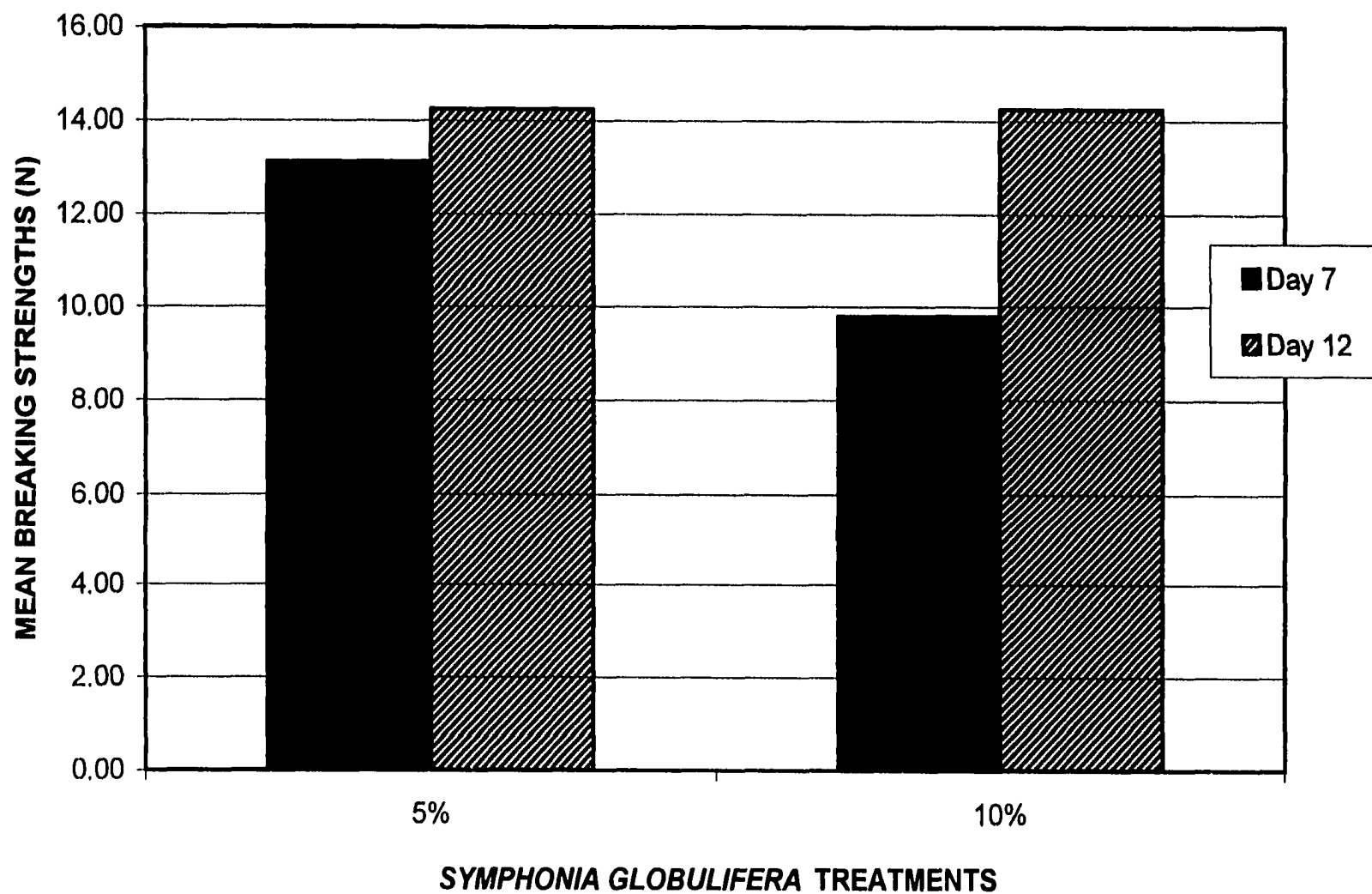
As with *Hamelia patens*, the first analysis was to determine if there was a significant difference in wound healing between Day 7 and Day 12 post-wounding for the treated wounds (Table 8.7, Figure 8.4).

Table 8.7. Comparisons of breaking strength between Day 7 and Day 12 harvests for 5% w/w and 10% w/w *ohoru* (*Symphonia globulifera* L.f.) treatments using the double incision wound healing bioassay.

Comparison	Breaking Strength Means (kg·m/s ²)	Signif.
Day 7 Group I (5% w/w)	13.11	ns
and Day 12 Group I (5% w/w)	14.24	
Day 7 Group II (10% w/w)	9.79	ns
and Day 12 Group II (10% w/w)	14.24	

ns = not significant

Figure 8.4.
Mean breaking strengths at 7 and 12 days post-wounding for 5% w/w and 10% w/w
***Symphonia globulifera* L.f. treatments using the double incision wound healing bioassay.**



The second analysis was to determine if there was a difference in wound healing between the treatment and control sides (Table 8.8, Figure 8.5 and 8.6).

Table 8.8. Comparison of breaking strength means between treatments and controls for ohoru (*Symphonia globulifera* L.f.) using the double incision wound healing bioassay.

Comparison	Breaking Strength Mean (kg·m/s ²)	Signif.
Day 7 Group I (5% w/w) and Day 7 Group I (DMSO+PJ)	13.11 13.58	ns
Day 12 Group I (5% w/w) and Day 12 Group I (DMSO+PJ)	14.24 13.89	ns
Day 7 Group II (10% w/w) and Day 7 Group II (DMSO+PJ)	9.79 9.19	ns
Day 12 Group II (10% w/w) and Day 12 Group II (DMSO + PJ)	12.24 13.92	ns

ns = not significant

Figure 8.5.
Comparison of breaking strength means between 5% w/w *Symphonia globulifera* L.f. treatment and control (DMSO+PJ) using the double incision wound healing bioassay.

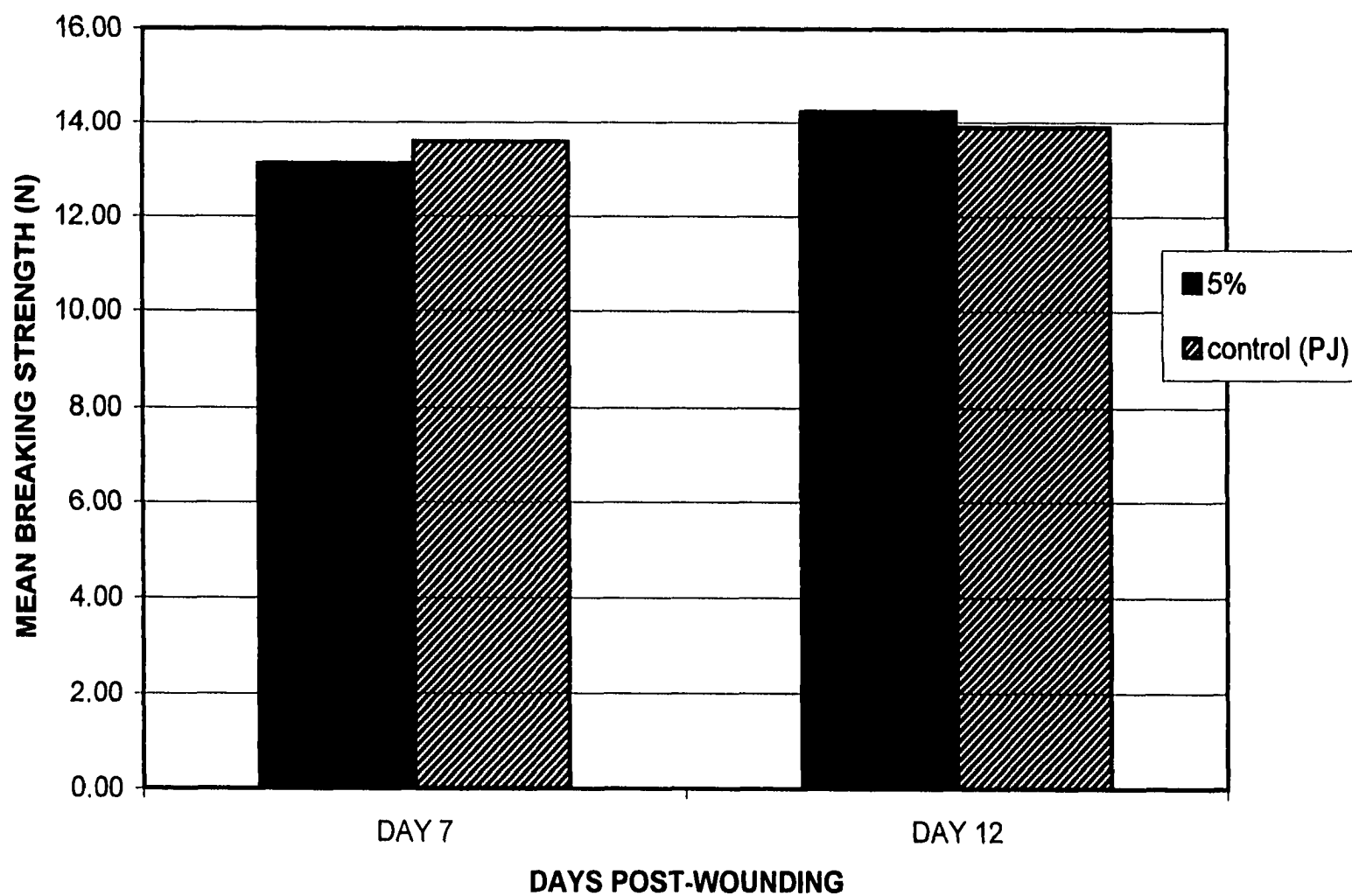
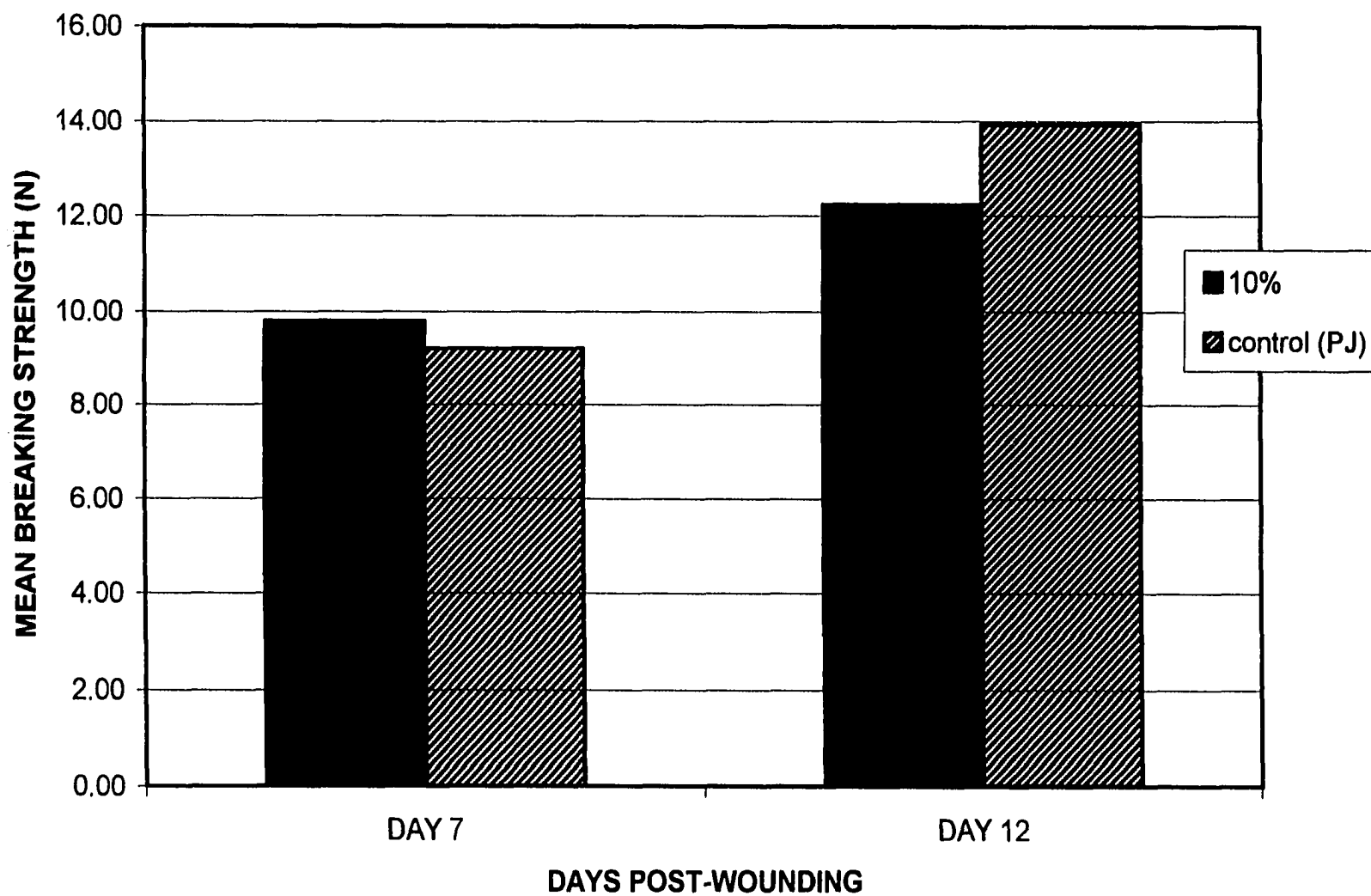


Figure 8.6.
Comparison of breaking strength means between 10% w/w *Symphonia globulifera* L.f. treatment and control (DMSO+PJ) using the double incision wound healing bioassay.



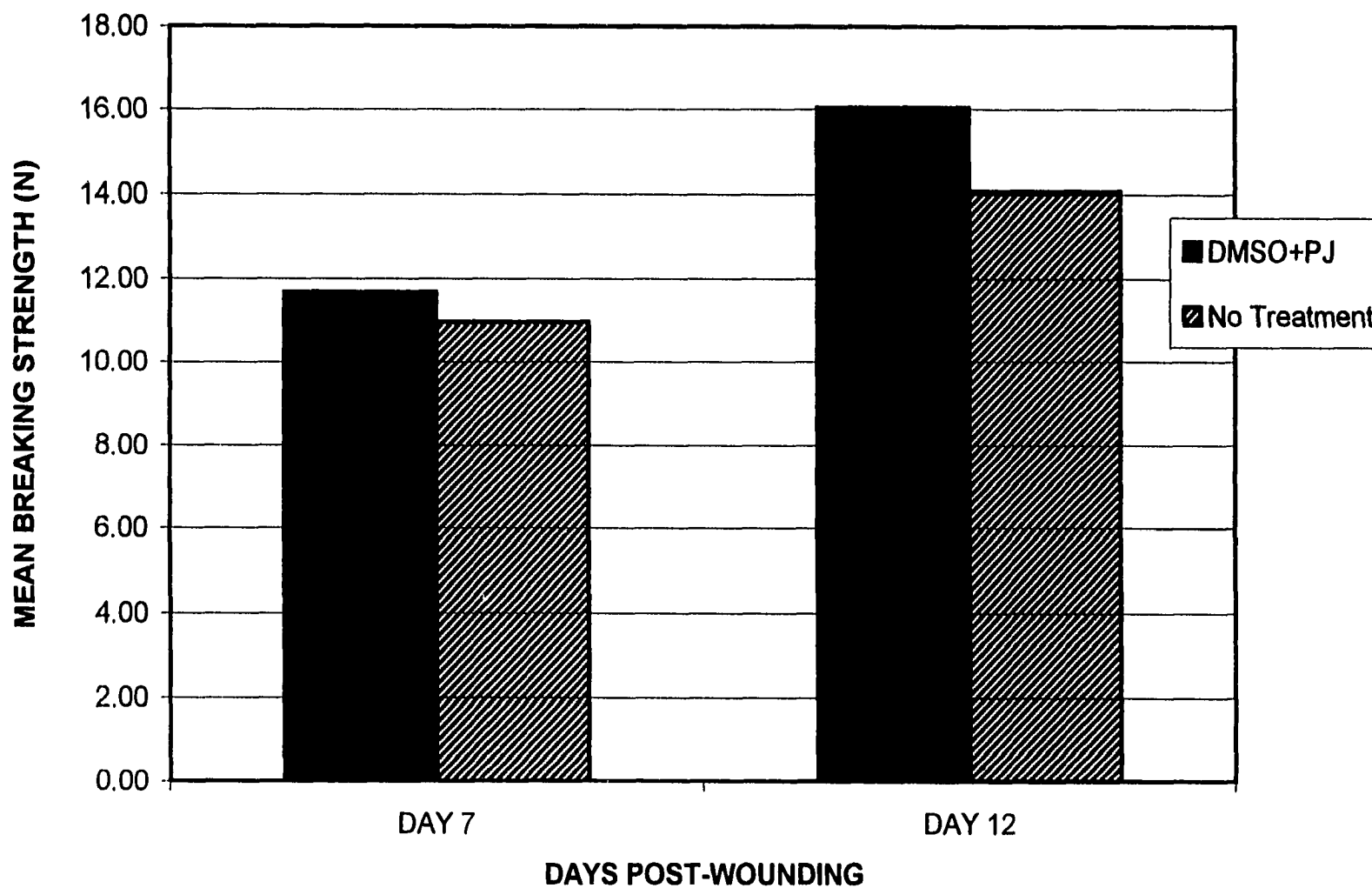
The final *Symphonia globulifera* bioassay analysis was carried out to determine if there was any measurable difference in breaking strength between the DMSO+PJ and no treatment groups (Table 8.9, Figure 8.7).

Table 8.9 Comparison of breaking strength between Group III controls using the double incision wound healing bioassay.

Comparison	Breaking Strength Mean (kg·m/s ²)	Signif.
Day 7 Group III (DMSO + PJ) and Day 7 Group III (no treatment)	11.69 10.97	ns
Day 12 Group III (DMSO + PJ) and Day 12 Group III (no treatment)	16.04 14.07	ns

ns = not significant

Figure 8.7.
Comparison of breaking strength means between wounds treated with DMSO+PJ and those receiving no treatment for the *Symphonia globulifera* double incision wound healing bioassay.



K. Discussion of Double Incision Wound Healing Bioassay Using *Ohoru* (*Symphonia globulifera* L.f.)

The results of the double incision wound healing model for 5% w/w and 10% w/w ***ohoru*** treatments (Table 8.7, Figure 8.4) demonstrate that there is no significant increase in breaking strength between Day 7 and Day 12. For the 5% w/w ***ohoru*** double incision treatment group, the breaking strength at Day 7 and Day 12 is nearly the same as that of Day 12 for the 5% w/w and 10% w/w ***ohoru*** treatments in the single incision wound healing bioassays. For the 10% w/w ***ohoru*** double incision treatment group, there is a change in breaking strength from Day 7 to Day 12, 9.74 N and 14.24 N, respectively, but it is not enough to be statistically significant.

In the second analysis between treatment and control (Table 8.8, Figure 8.5 and 8.6), the 5% w/w treatment and control sides were not significant at both Day 7 and Day 12. In fact, the breaking strength changed very little between 5% w/w treatment and control wounds from Day 7 to Day 12. At Day 12, the 5% treatment side fared a little better but it was not significant. For the 10% treatment and control sides at Day 7, there was no difference between 10% w/w and control sides. At Day 12, there was very little difference between the two sides although the control group had a slightly higher breaking strength, an indication that the control group was doing a little better at wound healing than the 10% w/w treatment.

The analysis of the control groups between wounds treated with the positive control (DMSO+PJ) and those receiving no treatment revealed no statistical difference between Day 7 and Day 12. This time, however, the positive control side (DMSO+PJ) did a little better, at both Day 7 and Day 12, than the untreated side.

The single incision wound healing bioassay results for *ohoru* demonstrate that wound healing is occurring and may be doing better than the control groups. However, the results from the double incision wound healing bioassay suggest that *ohoru* has no significant affect on breaking strength and may, at Day 12, have a weaker breaking strength than the control group. I speculate that this happened because the *ohoru* extract treatment preparation (*ohoru* + DMSO + PJ), by the time the second bioassay was being carried out, was old. The extract was collected in early April and the second bioassay was not started until mid-May. Even though the extract, after being prepared with petroleum jelly and DMSO, had been kept in the freezer to maintain its freshness, it may have oxidized nonetheless. *Ohoru* sap oxidizes very easily. Daily exposure of the prepared treatments may have caused the *ohoru* to oxidize. The single incision wound healing bioassay, which was carried out soon after my departure from the Winikina region of the Orinoco River Delta, showed more bioactivity than the double incision wound healing bioassay results. This may have been because the extract was relatively fresh for the single incision wound healing bioassay but was slowly becoming oxidized.

The laboratory results of the double incision wound healing bioassay do not corroborate the ethnobotanical use of **ohoru** (*Symphonia globulifera* L.f.) as a wound healing plant. Does this mean that the Warao use of this plant as a treatment for non-venomous laceration wounds is ineffective? Absolutely not. This will be the discussion for the final chapter of this dissertation.

Chapter 9.

Dissertation Discussion

A. Summary

The first major step of this dissertation was to establish a method to measure plant use knowledge and, using this data, select the plant reported most often by the Winikina Warao of the Orinoco River Delta, Venezuela, as a treatment for non-venomous laceration wounds. I administered a questionnaire to 40 randomly selected respondents of two villages, Morichitos and España, that measured plant use knowledge of 18 selected plants. Reported Use Value (RU), Reported Use Value for a specific plant part (RU_[plant part]), Plant Part Value (PPV), Specific Use Value (SU), Intraspecific Use Value (IUV), and Overall Use Value (OUV) were estimated for the 18 plants (see Tables 5.11-5.46 and Figures 5.5-5.22). The plants from the questionnaire reported for treating non-venomous laceration wounds were ranked according to OUV. I then selected the plant with highest OUV for wound healing, **ohoru** (*Symphonia globulifera* L.f.), for *in vivo* wound healing analysis.

The second major step of this dissertation was to carry out wound healing bioassays to determine if the plant's reported use for wound healing was corroborated in a controlled, laboratory setting. Prior to my trip to Venezuela, I established a linear incision wound healing bioassay protocol using the medicinal plant, *Hamelia patens* Jacq. The results, which showed that *H. patens* has

wound healing bioactivity, are discussed in Chapter 7. After selecting **ohoru** from the questionnaire as the plant with highest Overall Use Value for wound healing, I collected fresh **ohoru** extract from the cortex of *Symphonia globulifera* L.f. trees in the Winikina region of the Orinoco River Delta. I carried out a single and a double linear incision wound healing bioassay, using 5% w/w and 10% w/w **ohoru** preparations for each bioassay. I then compared breaking strength means of treatment and control groups to determine if **ohoru** increases, decreases, or does not affect wound breaking strength when compared to control groups.

The single incision wound healing bioassay demonstrated that wounds treated with **ohoru** are healing at a normal rate. Day 12 breaking strength means of treated wounds are significantly higher than those for Day 7. The double incision wound healing bioassay was carried out to determine if treatments enhance wound healing more than the control groups. The double incision wound healing bioassay results, presented in Chapter 8, demonstrate that **ohoru** does not do better than the control group in affecting breaking strength. In fact, for the 10% treatment, breaking strength means for wounds treated with **ohoru** are less than the control group means. One could speculate that because the laboratory results are negative, the reported wound healing use of **ohoru** has not been corroborated. This brings into question two types of efficacy: 1) efficacy as reported by the Winikina Warao and 2) efficacy as measured in the laboratory.

a. Efficacy as reported by the Winikina Warao

A unique feature of this study was that the study group was randomly selected from all villagers who were 15 years of age or older. I did not limit the study population to village healers (shaman and herbalists). As evidenced by the questionnaire results (Tables 5.11-5.96), every person in the study group had varying degrees of plant use knowledge. This allowed for a greater dimension of plant use knowledge among this population. Focusing on specialists, such as herbalists or shaman, with specialized healing knowledge and powers, maintains a biased view of the healing system utilized by a group of people. It is not only these specialists that know about medicinal plants. Knowledge of medicinal plants is carried to varying degrees by almost everyone in the community. Limiting respondent population to specialized healers would negate the fact that people turn to family and friends for medical information before turning to specialized healers (Etkin, Ross, & Muazzamu, 1990).

The questionnaire, as described in Chapter 4, was designed to find out if the Winikina Warao reported any of seven plants known to be used to treat non-venomous laceration wounds. In fact, nine (9) plants were reported to be used for wound healing. Of these, six (**ohoru**, **samariya**, **bihibihidu**, **anare**, **ohidu**, **usiru**) had been reported in the past (W. Wilbert, 1986; personal field notes). The newly reported plants for wound healing were **mango**, **iburu**, and **korokororo**. Using their Overall Use Values (OUV) for wound healing, **ohoru** emerged as the plant with highest OUV for wound healing. Eleven (28%) respondents reported **ohoru** as a treatment for wounds. The questionnaire

results demonstrated that the use of **ohoru** as a wound healing plant continues to be popular. Thus, the efficacy of **ohoru** as a wound healing plant, as reported by the Winikina Warao, is corroborated.

b. Efficacy as measured in the laboratory

On the other hand, **ohoru** treatments used for the double incision wound healing bioassay did not do as well or better than the control group in the laboratory. This could have been due to a number of reasons. The first reason which may have contributed to this unexpected result could have been experimental error. However, the same methodology used for the *Hamelia patens* double incision wound healing bioassays was used for the double incision bioassays for the **ohoru** treatments. The only difference was that different anesthetics were used in Venezuela. This had a negligible, if any, affect on the wounds.

Another reason for the unexpected results could have been that the sample size for the bioassays was too small to make a reliable measurement. The third reason may have been that by the time the double incision wound healing bioassay took place, the 5% w/w and 10% w/w **ohoru** treatments had lost their potency as they were over a month old. Even though the treatment ointments were kept in a tightly closed container and in a freezer to help maintain freshness, this may have not been enough to keep **ohoru** from oxidizing. In addition, the mixture of **ohoru**+DMSO+PJ may have helped stabilize the **ohoru** but it may not have been enough to prevent oxidation. In conjunction with this, it is not known what structural changes, if any, DMSO has on **ohoru**. It is evident

in the single incision wound healing bioassay that normal wound healing is occurring because there is a significant difference in breaking strength means between Day 7 and Day 12 for the 5% w/w and 10% w/w treatments. Previous studies of DMSO on wound healing assure that DMSO's affect on wound healing is negligible (Goldblum, Alvarez, Mertz, et al., 1983). Also, DMSO had been used as a solvent in the past for another plant latex which has received considerable attention for its wound healing properties: *Sangre de Drago*, from *Croton lechleri* Muell.-Arg. (Porris-Reyes, Lewis, Roman, et al., 1993). Thus, experimental error, sample group size, extract preparation, oxidation of *ohoru*, and use of DMSO, may have contributed to some degree to the negative results of the double incision wound healing bioassay.

More importantly, “phytochemical and clinical investigations of plants processed in ways different from preparation in the study population tell us something interesting about the plant and its pharmacological potential but not necessarily about how it affects the health of populations in which it is used” (Etkin, 1990, p. 154). In this case, the efficacy of *ohoru* is confirmed by the number of Winikina Warao respondents who reported its use but it is not confirmed by the laboratory results.

The inability of the extract to show a significant difference in breaking strength than the control group does not discount the use of *ohoru* as an efficacious wound healing plant used by the Winikina Warao. As Etkin (1988) points out, “plant use and other medical behaviors are effective if they effect or assist in producing the requisite, culturally defined outcomes” (p. 301).

c. Suggestions for improving the bioassays

The selection and evaluation of **ohoru** (*Symphonia globulifera* L.f.) for this study represents only one plant for one use. In addition to addressing the factors which may have contributed to the negative bioassay results for **ohoru**, as previously discussed, it would have been better to do the bioassays directly in the field. According to the Winikina Warao, **ohoru** sap is applied directly from the tree onto the wound. In order to mimic this use, a group of mice (40 or more), instead of rats, could be taken to the Orinoco River Delta to the area where the *Symphonia globulifera* L.f. trees grow. The rats would be acclimated for a few days in the Delta and then the bioassays carried out. This way, fresh **ohoru** extract could be used on a daily basis, doing away with the use of dimethyl sulfoxide or petroleum jelly. As a way to learn more about the wound healing potential of **ohoru**, histological evaluation of treated wound tissue of the mice could also be carried out to measure fibroblast migration, an indicator of wound healing activity (Mustoe, Pierce, Thomason, et al., 1987).

The best scenario for measuring plant use efficacy would be to carry out clinical trials within the population who reported the use. In the case of the Winikina Warao, this could be carried out in *Medicatura Herbig* in **Nabasanuka**. A clinical trial involving human subjects would provide highly reliable data to determine if using a plant for a specific use works better or worse than a control. Either the plant works as it has been reported or it works better or worse than a control plant with similar known use. A variety of parameters would have to be established to keep the trial as unbiased as possible and only those

Warao who report laceration wounds would be treated. Preliminary laboratory analyses of these plants could also be useful. The results of any toxicology results would be presented in a culturally appropriate manner so that it fits in with native health care perceptions (De Smet, 1991).

The results obtained from the questionnaire are promising. Using a questionnaire with the Winikina Warao was successful. The selection of *ohoru*, along with eight other plants with wound healing reported use, demonstrates that the Winikina Warao, and anyone, I believe, is capable of participating in a study using a similar methodology. Although laboratory results were not what I expected, at least I know that *ohoru* continues to be reported as a wound healing plant.

The Warao should be encouraged to continue using their medicinal plants. Although they are not accustomed to planting wild plants in their home gardens, creating medicinal plant gardens to help preserve plant knowledge would be an excellent way to encourage medicinal plant use and foster the idea of forest conservation at the same time. The gardens could be set up as communal property in villages and as part of the clinics which operate in the Delta, for example, *Medicatura Herbig* in the village of Nabasanuka. If the plants are kept *in situ*, then the cultural context within which these plants are used can be reinforced. If it was necessary, a wide range of bioassays could be designed and carried out by Venezuelan and other institutions to measure medicinal plant efficacy. Classes could be taught by Warao to their family and friends on uses of medicinal plants. Some Warao could be trained in Venezuela or other

institutions on how to present the classes, how to collect important plant use data, and how to carry out appropriate plant analysis. The courses could also teach tropical forest conservation and public health practices to reduce incidence of infectious diseases with high incidence rates (e.g., helminthiasis, diarrhea). Involving the Winikina Warao would empowered them to carry on their legacy as the survivors of El Dorado (J. Wilbert, 1972).

B. Ethnobotany Today

The idea that discovering medicinally useful plants will provide wealth to indigenous communities is an illusion. As Balick and Mendelssohn (1995, 1997) have illustrated, the chance of getting a “hit” from a medicinal plant is not only rare but finite. Also, because so many people are involved in the process of drug discovery, the money that would eventually come from the marketing of a new drug would only trickle down to the keepers of this indigenous knowledge. Although there has been some effort to provide immediate benefits to those people who share their plant use knowledge (notably, Shaman Pharmaceuticals), the reality is that those with traditional knowledge have to wait many years for significant monetary benefits to come to their communities, if at all. Also, if a novel compound is found from a plant and the benefits are to be shared by the pharmaceutical company, government, and the people, the tentacles of bureaucracy would make it difficult for indigenous people to collect their due part. If ethnobotany is going to focus on medicinal plants, then it should do so to maintain the knowledge of plants people use. This is similar to using ethnobotanical studies to argue for the conservation of tropical forests. The

ethnobotanist should be involved in the health and welfare of the people with whom he/she works.

As more and more ethnobotanical information is collected from indigenous people throughout the world, perhaps it is time to look at cross-sectional and longitudinal studies to measure what plant information is being kept, what is being lost, and what is being added. Not only is an evaluation of current plant use needed, but we should also understand how and why this information changes over time. Tropical forest conservation relies on ecological data collected at different points in time, so, too, should ethnobotanical data look at the use of plants by a group of people over different points in time. As evidenced by the questionnaire used for this study, Warao knowledge of wound healing plants remains strong. However, there is no way to know for sure what overall changes are taking place in Winikina Warao plant use knowledge or if this knowledge is increasing, decreasing or staying the same. The questionnaire used for this study can be expanded to include all known useful plants and administered again in the next few years, may measure whether plant use knowledge is changing for the Winikina Warao.

Large groups of Warao are migrating to Caracas and other cities in order to raise money by selling hammocks and small baskets woven from **ohidu** (*Mauritia flexuosa* L.f.) palm fiber. These migrations have brought confusion not only to the Warao but to the *criollo* population as well. The authorities in Caracas do not know what to do until the Warao became a nuisance by building makeshift tents in already overcrowded areas. The Warao are rounded up by the

Metropolitan Police and taken by bus and airplane to Tucupita “for their own good.” But the Warao return.

The lure for migration to the big cities of Venezuela by the Warao is economics. Hammocks and baskets can be sold for a much higher price than anywhere in the Delta. There are few jobs in the Delta, except in Tucupita, and most of these are taken by *criollos*. There is very little tourism, and what little there is, usually takes place in Tucupita and surrounding towns. Begging for money at the entrances of Caracas subways or at bus stops appears to be more lucrative. As one Warao told me, “People like me [in Caracas]. I put my hand out and they give me money. I can make more money in one week than I could ever make in one year in the Delta. In the Delta, no one gives me money. I don’t have a job and the government doesn’t care about me or my family or the Warao.”

By staying away from their traditional homeland, even by staying in Tucupita or the Delta port town of Barrancas, the Warao neglect their swiddens which must be prepared and planted with careful timing in order to produce a viable harvest. Most significantly, they neglect their traditional history.

Many adult Warao have complained to me that they are losing ground to outside forces as their children speak more Spanish than Warao and adopt non-Warao customs more and more each day. Knowledge of medicinal plants and cultural traditions of time past should be reinforced, especially among the children.

I believe the Winikina Warao, both young and old, should be taught about all aspects of plant use. The Winikina Warao may not be the same people of 75 years ago but they have a right to be proud and to practice their customs. They are a highly dynamic and intelligent people. All they need are the tools and the knowledge of how to use those tools to actively participate in this ever-changing world.

APPENDIX

APPENDIX A**Letter of support from the Instituto Venezolano de Investigaciones Cientificas**

INSTITUTO VENEZOLANO DE INVESTIGACIONES CIENTIFICAS
CENTRO DE ESTUDIOS AVANZADOS

APARTADO POSTAL 21817
CARACAS 1020A-VENEZUELA
CABLES IVICSAS-CARACAS

TELF.: (02) 504-1130 ; -1233; -1255
TELEFAX: (58) (2) 504.1089
TELEX: 21.338, 21.657

Altos de Pipe, 18 de diciembre de 1998
CE/468/98

Ciudadano
Alfredo Gómez-Veloz
Centro de Biofísica y Bioquímica
I.V.I.C.
Presente

Por este medio me permito comunicarle que ha sido aprobada su solicitud de ingreso como Estudiante Tesista de Postgrado en el laboratorio de Fisiología Gastrointestinal del Centro de Biofísica y Bioquímica, bajo la tutoría del Dr. Fabián Michelangeli.

Se ha enviado a su tutor, una planilla de Informe de Ingreso, la cual debe ser recogida por usted y entregada personalmente en este Centro.

Al momento de entregar este Informe en el CEA, usted debe firmar el Convenio correspondiente y de inmediato se iniciarán los trámites administrativos respectivos.

Sin otro particular, quedo de usted,

Atentamente,

Dr. Carlo Caputo
Decano

Centro de Estudios Avanzados

c.c. Dr. Fabián Michelangeli
Dr. Jesús del Castillo
CC/MCP/asu

APPENDIX B

Letter of support from Fundación La Salle



**FUNDACION LA SALLE DE CIENCIAS NATURALES
INSTITUTO CARIBE DE ANTROPOLOGIA Y SOCIOLOGIA**

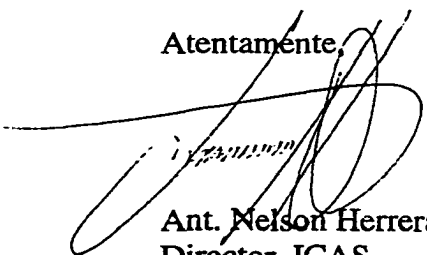
Caracas, 29 de octubre de 1998

A QUIEN PUEDA INTERESAR

Por medio de la presente, en mi carácter de Director hago constar que el Licen. Alfredo Gómez Beloz del Institute of Economic Botany de New York, esta acreditado a nuestro instituto como investigador asociado. El realizará estudios en el Delta del Orinoco, en seis rancherías distintas. Estos se centraran en reconocimientos botánicos de la flora del lugar. Contribuyendo al rescate de la biodiversidad.

Pido respetuosamente se le preste toda la colaboración que puedan darle durante todo el tiempo que requiera su investigación a este miembro de nuestra Instituto.

Atentamente,


Ant. Nelson Herrera
Director, ICAS

**FUNDACION LA SALLE
INSTITUTO CARIBE DE
ANTROPOLOGIA Y SOCIOLOGIA
APARTADO CORREO 1999
CARACAS - VENEZUELA**

APPENDIX C

Decisión 391, Régimen Común sobre Acceso a los Recursos Genéticos as published in the *Gaceta Oficial del Acuerdo de Cartagena*, Año XII, No. 213, July 17, 1996 (English translation from www.comunidadesandinas.org).

DECISION 391

Common Regime on Access to Genetic Resources

THE COMMISSION OF THE CARTAGENA AGREEMENT,

HAVING SEEN: The Third Temporary Provision of Commission Decision 345 and Board Proposal 284/Rev. 1;

WHEREAS:

The Member Countries have sovereignty over the use and development of their resources, a principle that has also been ratified by the Agreement on Biological Diversity, signed in Rio de Janeiro in June 1992 and legalized by the five Member Countries;

The Member Countries possess a sizeable biological and genetic heritage that should be preserved and developed on a sustainable basis;

The Andean countries are characterized by their multi-ethnic and pluricultural nature;

The biological diversity, the genetic resources, their endemism and rarity, as well as the know-how, innovations and practices of the native, Afro-American and local communities associated with them, have a strategic value in the international context;

It is necessary to recognize the historic contribution made by the native, Afro-American, and local communities to the biological diversity, its conservation and development and the sustained use of its components, as well as to the benefits generated by that contribution;

A close interdependence exists between the native, Afro-American and local communities and the biological resources that should be reinforced, in keeping with the conservation of the biological diversity and the economic and social development of those communities and of the Member Countries;

It is necessary to strengthen integration and scientific, technical and cultural cooperation, while moving ahead with the harmonious and comprehensive development of the Member Countries;

Genetic resources have an enormous economic value as a primary source of products and processes for industry;

DECIDES:

To approve the following:

COMMON REGIME ON ACCESS TO GENETIC RESOURCES

TITLE I

ON THE DEFINITIONS

Article 1.- The following definitions shall apply for purposes of this Decision:

ACCESS: the obtaining and use of genetic resources conserved in situ and ex situ, of their by-products and, if applicable, of their intangible components, for purposes of research, biological prospecting, conservation, industrial application and commercial use, among other things.

ACCESS CONTRACT: agreement between the Competent National Authority in representation of the State, and a person that establishes the terms and conditions for access to genetic resources, their by-products and, if applicable, the associated intangible component.

ACCESS RESOLUTION: an administrative order issued by the Competent National Authority that executes the access to genetic resources or their by-products, after having fulfilled all requirements or conditions stipulated in the access procedure.

BIOLOGICAL DIVERSITY: the variability of living organisms of any source whatsoever, including, among others, land and ocean ecosystems and other aquatic ecosystems, as well as the ecological complexes of which they are a part. Covers the diversity that exists within each species and between species and within ecosystems as a result of natural and cultural processes.

BIOLOGICAL RESOURCES: individuals, organisms or parts of them, populations or any biotic component of value or of real or potential use that contains a genetic resource or its by-products.

BIOTECHNOLOGY: any technological application that utilizes biological systems or live organisms, parts of them or their by-products, to create or modify products or processes for specific uses.

BY-PRODUCT: a molecule, a combination or mixture of natural molecules, including crude extracts of live or dead organisms of biological origin that come from the metabolism of living beings.

COMPETENT NATIONAL AUTHORITY: State entity or public institution appointed by each Member Country, authorized to supply the genetic resource or its by-products and therefore to sign or supervise the access contracts, to take the actions provided for in this common regime and to ensure their performance.

COUNTRY OF ORIGIN OF THE GENETIC RESOURCE: country that possesses genetic resources in in situ conditions, including those which, having been in in situ conditions, are now in ex situ conditions.

ECOSYSTEM: a dynamic complex of communities of human beings, plants, animals and micro-organisms and their non-living medium that interact as a functional unit.

EX SITU CONDITIONS: those in which the genetic resources are not found in in situ conditions.

EX SITU CONSERVATION CENTER: a person or institution recognized by the Competent National Authority that conserves and collects genetic resources or their by-products outside their in situ conditions.

GENETIC DIVERSITY: variation of genes and genotypes between and within species. Sum total of the genetic information contained in biological organisms.

GENETIC EROSION: the loss of or decrease in genetic diversity.

GENETIC RESOURCES: all biological material that contains genetic information of value or of real or potential use.

IN SITU CONDITIONS: those in which the genetic resources are found in their ecosystems and natural environments; in the case of domesticated or cultivated species or those having escaped domestication, in the environments where they developed their specific properties.

INTANGIBLE COMPONENT: all know-how, innovation or individual or collective practice, with a real or potential value, that is associated with the genetic resource, its by-products or the biological resource that contains them, whether or not protected by intellectual property regimes.

NATIONAL SUPPORT INSTITUTION: national institution devoted to biological research of a scientific or technical nature, that accompanies the applicant and participates jointly with it in the access activities.

NATIVE, AFRO-AMERICAN OR LOCAL COMMUNITY: a human group whose social, cultural and economic conditions distinguish it from other sectors of the national community, that is governed totally or partially by its own customs or traditions or by special legislation and that, irrespective of

its legal status, conserves its own social, economic, cultural and political institutions or a part of them.

PROGRAM FOR THE LIBERALIZATION OF GOODS AND SERVICES: a program whose purpose is to eliminate levies and restrictions of all kinds on the importation of goods originating in the territory of any Member Country, pursuant to the provisions of the pertinent chapter of the Cartagena Agreement and all other applicable rules and regulations of its body of law.

SUPPLIER OF THE BIOLOGICAL RESOURCE: a person empowered by this Decision and complementary national legislation to supply the biological resource that contains the genetic resource or its by-products.

SUPPLIER OF THE INTANGIBLE COMPONENT: a person that, through an access contract and pursuant to this Decision and to complementary national legislation, is empowered to supply the intangible component associated with the genetic resource or its by-products.

SUSTAINABLE USE: use of the components of biological diversity in a way and at a rate that does not cause their reduction in the long term and that enables them to maintain their possibilities for satisfying the needs and the aspirations of existing and future generations.

SYNTHESIZED PRODUCT: a substance obtained through the artificial processing of genetic information or of information from other biological molecules. Includes semi-processed extracts and substances obtained by converting a by-product through an artificial process (hemisynthesis).

TITLE II

ON THE PURPOSE AND AIMS

Article 2.- The purpose of this Decision is to regulate access to the genetic resources of the Member Countries and their by-products, in order to:

- a) Establish the conditions for just and equitable participation in the benefits of the access;
- b) Lay the foundations for the recognition and valuation of the genetic resources and their by-products and of their associated intangible components, especially when native, Afro-American or local communities are involved;
- c) Promote conservation of the biological diversity and the sustainable use of the biological resources that contain genetic resources;

- d) Promote the consolidation and development of scientific, technological and technical capacities at the local, national and subregional levels; and
- e) Strengthen the negotiating capacity of the Member Countries.

TITLE III

ON THE SCOPE

Article 3.- This Decision is applicable to genetic resources for which is the Member Countries are the countries of origin, to their by-products, to their intangible components and to the genetic resources of the migratory species that for natural reasons are found in the territories of the Member Countries.

Article 4.- The following are excluded from the scope of this Decision:

- a) Human genetic resources and their by-products; and
- b) The exchange of genetic resources, their by-products, the biological resources containing them, or their associated intangible components among native, Afro-American and local communities of the Member Countries for their own consumption, based on their customary practices.

TITLE IV

ON THE PRINCIPLES

CHAPTER I

ON THE SOVEREIGNTY OVER GENETIC RESOURCES AND THEIR BY-PRODUCTS

Article 5.- The Member Countries exercise sovereignty over their genetic resources and their by-products and consequently determine the conditions for access to them, pursuant to the provisions of this Decision.

The conservation and sustainable use of the genetic resources and their by-products are regulated by each Member Country in keeping with the principles and provisions of the Biological Diversity Agreement and of this Decision.

Article 6.- The genetic resources and their by-products which originated in the Member Countries are goods belonging to or the heritage of the Nation or of the State in each Member Country, as stipulated in their respective national legislation.

Those resources are inalienable, not subject to prescription and not subject to seizure or similar measures, without detriment to the property regimes applicable to the biological resources that contain those genetic resources, the land on which they are located or the associated intangible component.

CHAPTER II

ON THE RECOGNITION OF KNOW-HOW,

INNOVATIONS AND TRADITIONAL PRACTICES

Article 7.- The Member Countries, in keeping with this Decision and their complementary national legislation, recognize and value the rights and the authority of the native, Afro-American and local communities to decide about their know-how, innovations and traditional practices associated with genetic resources and their by-products.

CHAPTER III

ON TRAINING, RESEARCH, DEVELOPMENT AND

THE TRANSFER OF TECHNOLOGY

Article 8.- The Member Countries favor the establishment of scientific and technical training programs, as well as the execution of research projects that promote the identification, registration, characterization, conservation and sustainable use of the biological diversity and of the by-products of genetic resources that help to satisfy local and Subregional needs.

Article 9.- The Member Countries, recognizing that technology, including biotechnology, and both the access to it and its transfer are essential to the attainment of the objectives of this Decision, shall ensure and facilitate, through the corresponding contracts, the access to technologies that utilize genetic resources and their by-products, that are appropriate for the conservation and sustainable use of the biological diversity and that do not cause damage to the environment.

CHAPTER IV

ON SUBREGIONAL COOPERATION

Article 10.- The Member Countries shall define mechanisms for cooperation on matters of common interest concerning the conservation and sustainable use of genetic resources and their by-products and the associated intangible components.

They shall also establish Subregional technical and scientific training programs on the information, follow-up, control and evaluation of activities

connected with those genetic resources and their by-products and for the performance of joint research.

CHAPTER V

ON NATIONAL TREATMENT AND RECIPROCITY

Article 11.- The Member Countries grant each other national, and not discriminatory, treatment in matters relating to access to genetic resources.

Article 12.- The Member Countries may grant national and non-discriminatory treatment to third countries that give them equal treatment.

CHAPTER VI

ON PRECAUTION

Article 13.- The Member Countries may adopt measures aimed to impeding genetic erosion or the degradation of the environment and of the natural resources. If the danger of serious and irreversible damage exists, the lack of scientific certainty should not be seized upon as a reason for postponing the adoption of effective measures.

The principle of precaution should be applied in keeping with the provisions in the Chapter on the Liberalization Program of the Cartagena Agreement and the other applicable rules and regulations of the body of law of this Agreement.

CHAPTER VII

ON FREE SUBREGIONAL TRAFFIC IN BIOLOGICAL RESOURCES

Article 14.- Provided that there is no access to the genetic resources contained in the biological resources referred to in this Decision, the provisions of this regime shall not hinder the use of and free movement of in those biological resources, nor the fulfillment of the provisions of the CITES Convention on health, food security, biosecurity and the obligations stemming from the Program of Liberalization of goods and services among Member Countries.

CHAPTER VIII

ON THE JURIDICAL SECURITY AND TRANSPARENCY

Article 15.- Provisions, procedures and acts of government authorities of the Member Countries with regard to access, shall be clear, effective, well-grounded and lawful.

The actions performed and information provided by individuals shall likewise be lawful, complete and truthful.

TITLE V
ON THE ACCESS PROCEDURE
CHAPTER I
ON THE GENERAL ASPECTS

Article 16.- All access procedures shall require the presentation, admittance, publication and approval of an application, the signing of a contract, the issuing and publication of the corresponding Resolution and the declarative registration of the acts connected with that access.

Article 17.- The applications for access and access contracts and, if appropriate, accessory contracts shall include conditions like the following:

- a) The participation of Subregional nationals in the research on genetic resources and their by-products and on the associated intangible component;
- b) Support for research within the jurisdiction of the Member Country of origin of the genetic resource or in any other Subregional Member Country that contributes to the conservation and sustainable use of the biological diversity;
- c) The strengthening of mechanisms for the transfer of know-how and technology, including biotechnology, that is culturally, socially and environmentally healthy and safe;
- d) The supply of information about the background and status of the science and about other matters that would contribute to a better knowledge of the situation regarding the genetic resource that originated in the Member Country, its by-product or synthesized product and its associated intangible component;
- e) The strengthening and development of the institutional capacity of the country or the Subregion in regard to genetic resources and their by-products;
- f) The strengthening and development of the capacities of the native, Afro-American and local communities with relation to the associated intangible components, the genetic resources and their by-products;
- g) The compulsory deposit of duplicates of all material collected, at institutions designated by the Competent National Authority;
- h) The obligation to inform the Competent National Authority about the results of the research carried out; and

- i) The terms for the transfer of the material to which third parties are given access.

Article 18.- The documents connected with the access procedure shall appear in a public file that the Competent National Authority shall keep.

That file shall consist of the following, at least: the application; the identification of the applicant, the resource supplier, and the national support person or institution; the site or area to which the access applies; the access methodology; the project proposal; the parts of the access contract that are not subject to confidentiality; the opinion about and registry of visits; and, if applicable, the evaluation studies of the economic, social and environmental impact or of the environmental permits.

Also included in the file are the Resolution executing the access, the reports supplied by the national support person or institution, and the follow-up and supervisory reports provided by the Competent National Authority or the entity delegated to perform that task. That file is open to consultation by any person.

Article 19.- The Competent National Authority may give confidential treatment to data and information supplied to it in the course of the access procedure or the contract performance, and not previously disclosed, which could be put to unfair commercial use by third parties, unless the knowledge of this data and information by the public is necessary to protect the social interest or the environment.

Accordingly, the applicant should state the grounds for its petition, accompanied by a non-confidential summary that will become a part of the public file.

The information or documents referred to in the second paragraph of Article 18 of this Decision cannot be made confidential.

The confidential aspects shall be covered in a separate file, in the custody of the Competent National Authority, and may not be disclosed to third parties, unless that is judicially ordered.

Article 20.- If the petition for confidential treatment fails to comply with the requirements established in the previous article, the Competent National Authority shall deny it as a matter of right.

Article 21.- The Competent National Authority shall keep a public registry where the following information shall be entered, among other data: the Resolution that may possibly deny the petition, the access contract signing, amendment, suspension and termination dates, the date and number of the Resolution executing or canceling it, the date and number of the Resolution, award or sentence determining the nullity or imposing penalties, with an indication of their kind and the parties, and accessory

contract signing, amendment, suspension, termination and nullification dates.

That registry shall be of a declaratory nature.

Article 22.- As stipulated in Article 15, the execution of the access is dependent upon the provision of full and reliable information by the applicant, as called for by law.

In this connection, the applicant should present the Competent National Authority with all of the information about the genetic resource and its by-products that it knows or is in a position to know at the moment the application is presented. That information shall include the present and potential uses of the resource, by-product or intangible component, their sustainability and the risks that could result from the access.

The statements made by the applicant in the application and in the contract, including their respective annexes, shall be in the nature of a sworn statement.

Article 23.- The permits, authorizations and other documents that support the investigation, obtaining, provision, transfer, etc., of biological resources, shall not determine, qualify or presume the authorization of the access.

Article 24.- It is forbidden to use genetic resources and their by-products in biological weapons or for practices that are harmful to the environment or to human health.

Article 25.- The transfer of technology shall be carried out in accordance with the provisions contained in the body of law of the Cartagena Agreement, complementary national provisions and such rules and regulations on biosecurity and the environment as the Member Countries may approve.

Article 26.- The access to and transfer of technology subject to patents or other intellectual property rights, shall be accomplished in keeping with the Subregional and complementary national provisions regulating that area.

CHAPTER II

ON THE APPLICATION FOR ACCESS

Article 26.- The procedure starts with the presentation to the Competent National Authority of an application for access which should contain:

- a) Identification of the applicant and, if pertinent, documents that accredit its legal capacity to make a contract;

- b) Identification of the supplier of the genetic and biological resources and their by-products or of the associated intangible component;
- c) Identification of the national support person or institution;
- d) Identification and curriculum vitae of the person responsible for the project and of his working group;
- e) The access activity applied for; and
- f) The location or area where the access is to be carried out, with an indication of its geographical coordinates.

The application shall be accompanied by the project proposal, considering the referential model the Board approves through a Resolution.

Article 27.- If the application with its accompanying project proposal is complete, the Competent National Authority shall accept it, assign it a presentation or filing date, record it in the report and enter it with a declarative intent in the public registry it shall keep for that purpose and open the corresponding file.

Were the application to be incomplete, the Competent National Authority would return it without delay, indicating the information that is missing, so that it might be completed.

Article 28.- Within five working days following the date of entry of the application in the public registry referred to in the previous article, an extract of that application shall be published in a newspaper with broad national circulation and in another medium of the place where the access is to be effected, so that those that wish to might supply information to the Competent National Authority.

Article 29.- Within thirty working days after its registration, the Competent National Authority shall evaluate the application, make the visits it deems necessary and issue a technical and legal opinion about its propriety or invalidity. That period may be extended to up to sixty working days if the Competent National Authority considers it desirable.

Article 30.- When the time limit stipulated in the previous article expires, or before that, if appropriate, the Competent National Authority shall accept or deny the application, based on the results of the opinion, the records of visits, the information supplied by third parties, and the fulfillment of the conditions established in this Decision.

The applicant shall be advised about the acceptance of the application and project proposal within five working days after this occurs. The access contract shall then be immediately drawn up and negotiated.

In the event that the application and project proposal are denied, this shall be communicated through a justified Resolution and the matter shall be considered finished. This does not, however, preclude the filing of such objections as are in order, according to the procedures established in the national legislation of Member Countries.

Article 31.- If required by the national law of the Member Country or if the Competent National Authority deems it necessary, the applicant shall comply with environmental provisions in effect.

The procedures that should be followed in that event shall be independent from those stipulated in this Decision and may be started beforehand. Nonetheless, they must be concluded before the expiration of the time limit stipulated in Article 29 and must be considered by the Competent National Authority in making its evaluation.

Were the Competent National Authority to require such studies, it could grant the applicant a supplementary period set exclusively in accordance with the time needed to complete and submit them for its consideration.

CHAPTER III

ON THE ACCESS CONTRACT

Article 32.- The parties to the access contract are:

- a) The State, represented by the Competent National Authority; and
- b) The applicant requesting the access.

The applicant must be legally empowered to make a contract in the Member Country in which it requests the access.

Article 33.- The terms of the access contract must be in keeping with the provisions of this Decision and Member Country national legislation.

Article 34.- The access contract shall bear in mind the rights and interests of the suppliers of genetic resources and their by-products, the biological resources that contain them and the intangible component as applicable, in accordance with the corresponding contracts.

Article 35.- When access is requested to genetic resources or their by-products with an intangible component, the access contract shall incorporate, as an integral part of that contract, an annex stipulating the fair and equitable distribution of the profits from use of that component.

The annex shall be signed by the supplier of the intangible component and the applicant for the access. It may also be signed by the Competent National Authority, in accordance with the provisions of national law of the Member Country. If that annex is not signed by the Competent National

Authority, it shall be subject to the suspensive condition referred to in Article 42 of this Decision.

Failure to comply with the stipulations of the annex shall constitute grounds for the rescission and nullification of the access contract.

Article 36.- The Competent National Authority may enter into access contracts with universities, research centers or well-known researchers to support the execution of several projects, as provided for in this Decision and in keeping with the national legislation of each Member Country.

Article 37.- The ex-situ conservation centers or other institutions that perform activities involving access to genetic resources or their by-products and, if appropriate, the associated intangible component, should enter into access contracts with the Competent National Authority, pursuant to this Decision.

That Authority may likewise sign access contracts with third parties in regard to genetic resources of which the Member Country is the country of origin and which have been deposited at those centers, bearing in mind the rights and interests referred to in Article 34.

CHAPTER IV

ON THE EXECUTION OF THE ACCESS

Article 38.- Once the contract has been adopted and signed, the corresponding Resolution shall be issued in a joint act. This resolution shall then be published together with an extract of the contract, in the Official Newspaper or a newspaper with wide national circulation. As of that moment, the access shall be considered to have been granted.

Article 39.- Such contracts as are signed in violation of the provisions of this regime shall be null and void. The nullification procedure shall be subject to the national provisions of the Member Country in which it is invoked.

Article 40.- The rescission or resolution of the contract shall be motive for the official cancellation of the registration by the Competent National Authority.

TITLE VI

ON THE ANCILLARY CONTRACTS TO THE ACCESS CONTRACT

Article 41.- Ancillary contracts are those that are signed in order to carry out activities connected with the genetic resource or its by-products, between the applicant and:

- a) The owner, possessor or manager of the land where the biological resource containing the genetic resource is located;
- b) The ex situ conservation center;
- c) The owner, possessor or manager of the biological resource containing the genetic resource; or
- d) The national support institution, with regard to activities that it should perform and that are not a part of the access contract.

Making an ancillary contract does not authorize access to the genetic resource or its by-product, and its contents are subject to the stipulations of the access contract as provided for in this Decision.

The national support institution must be accepted by the Competent National Authority.

Article 42.- Such ancillary contracts as are signed shall include a condition that subjects their execution to that of the access contract.

As of that moment, they shall become effective and binding and shall be governed by the mutually agreed terms, the provisions of this Decision and applicable Subregional and national legislation. The responsibility for their execution and compliance lies only with the parties to the contract.

Article 43.- Without detriment to what has been agreed upon in the accessory contract and independently of it, the national support institution shall be obliged to collaborate with the Competent National Authority in the follow-up and supervision of the genetic resources, by-products or synthesized products and associated intangible components, and to submit reports about the activities for which it is responsible, in the way or with the frequency that the Authority stipulates, according to the access activity.

Article 44.- The nullity of the access contract produces the nullity of the ancillary contract.

The Competent National Authority may also terminate the access contract when the nullity of the ancillary contract is declared, if the latter is essential for the access.

Its amendment, suspension, rescission or resolution may likewise produce the amendment, suspension, rescission or resolution of the access contract by the Competent National Authority if it substantially affects the conditions of the latter contract.

TITLE VII

ON THE LIMITATIONS TO ACCESS

Article 45.- Member Countries may establish, through an express legal rule, partial or total limitations on access to genetic resources or their by-products in the following cases:

- a) Endemism, rarity or danger of extinction of species, subspecies, varieties or races or breeds;
- b) Vulnerability or fragility of the structure or functioning of the ecosystems that could worsen as a result of access activities;
- c) Adverse effects of access activities on human health or on elements essential to the cultural identity of nations;
- d) Undesirable or not easily controlled environmental effects of access activities on the ecosystems;
- e) Danger of genetic erosion caused by access activities;
- f) Regulations on biosecurity; or
- g) Genetic resources or geographic areas rated as strategic.

TITLE VIII

ON VIOLATIONS AND SANCTIONS

Article 46.- Any person performing access activities without the respective authorization shall be liable for punishment.

Also to be sanctioned is any person carrying out transactions with regard to by-products or synthesized products of such genetic resources or the associated intangible component, that is not protected by the corresponding contracts, signed in keeping with the provisions of this Decision.

Article 47.- The Competent National Authority, pursuant to the procedure provided for in its own national legislation, may apply administrative sanctions, such as fines, preventive or definitive confiscation, temporary or definitive closing-down of establishments and disqualification of the violator from applying for new accesses in cases of violation of this regime.

Those sanctions shall be applied without detriment to the suspension, cancellation or nullification of the access, the payment of compensation for such damages and losses as are incurred, including those caused to the biological diversity, and the civil and criminal sanctions that may possibly be in order.

TITLE IX

ON THE NOTIFICATIONS BETWEEN MEMBER COUNTRIES

Article 48.- The Member Countries shall notify each other immediately through the Board, of all applications for access and access resolutions and authorizations, as well as of the suspension and termination of such contracts as are signed.

They shall also advise each other about the signing of any bilateral or multilateral agreement on the subject, which must be in keeping with the provisions of this Decision.

Article 49.- Without prejudice to the stipulations of the previous article, the Member Countries shall immediately inform each other through the Board of all provisions, decisions, regulations, judgments, resolutions and other rules and acts adopted nationally that have to do with the provisions of this Decision.

TITLE X

ON THE COMPETENT NATIONAL AUTHORITY

Article 50.- The Competent National Authority shall perform all of the functions conferred on it in this Decision and in Member Country national legislation. In this connection, it shall be empowered to:

- a) Issue the necessary internal administrative provisions to comply with this Decision and, until the appropriate Community rules and regulations are enacted, stipulate how the genetic resources and their by-products shall be identified and packed;
- b) Receive, evaluate, accept or deny applications for access;
- c) Negotiate, sign and authorize access contracts and issue the corresponding access resolutions;
- d) Ensure the rights of suppliers of biological resources that contain genetic resources and of the intangible component;
- e) Keep the technical files and the Public Registry of Access to Genetic Resources and their by-products;
- f) Keep a directory of persons or institutions pre-qualified to perform scientific or cultural support tasks;
- g) Amend, suspend, nullify or terminate access contracts and arrange their cancellation, as the case may be, in keeping with the terms of those contracts, this Decision and Member Country legislation;

- h) Oppose the suitability of the national support institution proposed by the applicant and demand its replacement by another, suitable one;
- i) Supervise and control compliance with the contractual conditions and the provisions of this Decision and accordingly establish such monitoring and evaluation mechanisms as it deems advisable;
- j) Review, in keeping with this Decision, contracts involving access already signed with other institutions or persons and carry out the corresponding actions for repossession;
- k) Delegate supervisory activities to other institutions, while keeping the responsibility and direction over that supervision, in conformity with national legislation;
- l) Supervise the state of conservation of the biological resources containing the genetic resources;
- m) Coordinate continuously with its respective liaison institutions all matters having to do with fulfillment of the provisions of this Decision;
- n) Keep the national inventory of genetic resources and their by-products;
- o) Keep in continuous contact with the competent national offices for industrial property and set up appropriate information systems with them; and
- p) All such other functions as the domestic legislation of the Member Country itself may assign it.

TITLE XI

ON THE ANDEAN COMMITTEE ON GENETIC RESOURCES

Article 51.- The Andean Committee on Genetic Resources is hereby created, such to be comprised of the Directors of the Competent National Authorities on matters of Access to Genetic Resources or their representatives, their advisors and such representatives of other interested sectors as each Member Country may designate.

The Committee shall be responsible for:

- a) Issuing national and Subregional recommendations for the best possible fulfillment of this Decision;
- b) Issuing technical recommendations on such matters as the Member Countries may submit for its consideration;

- c) Recommending the mechanisms for establishing an Andean information network on applications for access and access contracts in the Subregion;
- d) Recommending and promoting joint actions to strengthen Member Country capacity in research, management and transfer of technology connected with genetic resources and their by-products;
- e) Recommending to the Board for adoption through Resolutions, common documentation models, particularly those that will make it possible to easily verify the coding and identification of genetic resources and their by-products, as well as the legality of the access;
- f) Promoting management, surveillance, control and supervision of access authorizations relating to genetic resources and their by-products that exist in two or more Member Countries;
- g) Recommending and promoting joint emergency plans and warning mechanisms to prevent or resolve problems relating to access to genetic resources or their by-products;
- h) Taking cooperative actions with regard to genetic resources or their by-products;
- i) Drawing up their own internal regulations;
- j) Writing an explanatory manual of this Decision; and
- k) Such other functions as the Member Countries may assign to them.

COMPLEMENTARY PROVISIONS

FIRST.- The Member Countries shall, in keeping with their national legislation, set up or reinforce funds or other types of financial mechanisms financed by the profits from the access and resources from other sources to promote compliance with the aims of this Decision, under the direction of the Competent National Authority.

Through the Andean Committee on Genetic Resources, the Member Countries shall design and implement joint programs for the conservation of genetic resources and shall study the viability and desirability of creating an Andean Fund for their conservation.

SECOND.- The Member Countries shall not acknowledge rights, including intellectual property rights, over genetic resources, by-products or synthesized products and associated intangible components, that were obtained or developed through an access activity that does not comply with the provisions of this Decision.

Furthermore, the Member Country affected may request nullification and bring such actions as are appropriate in countries that have conferred rights or granted protective title documents.

THIRD.- The Competent National Offices on Intellectual Property shall require the applicant to give the registration number of the access contract and supply a copy of it as a prerequisite for granting the respective right, when they are certain or there are reasonable indications that the products or processes whose protection is being requested have been obtained or developed on the basis of genetic resources or their by-products which originated in one of the Member Countries.

The Competent National Authority and the Competent National Offices on Intellectual Property shall set up systems for exchanging information about the authorized access contracts and intellectual property rights granted.

FOURTH.- Such health certificates supporting the export of biological resources as are issued in accordance with Commission Decision 328, its amendments or addenda, shall incorporate the following statement at the end of the format: "Use of this product as a genetic resource is not authorized."

FIFTH.- The Competent National Authority may enter into, with the institutions referred to in Article 36, contracts for the deposit of genetic resources or their by-products or of the biological resources containing them, exclusively for purposes of their care, keeping those resources under its jurisdiction and control.

Likewise, it may make contracts that do not involve access, such as intermediation or administration contracts, in relation to genetic resources or their by-products or synthesized products, in keeping with the provisions of this Regime.

SIXTH.- When requesting access to genetic resources from protected areas or their by-products, the applicant must fulfill, in addition to the stipulations of this Decision, also the special national legislation on the subject.

FINAL PROVISIONS

FIRST.- Any disputes that may arise among Member Countries shall be settled as stipulated in the Andean body of law.

Any disputes that arise with third countries must be settled according to the provisions of this Decision. If a dispute arises with a third country party to the Agreement on Biological Diversity, signed in Rio de Janeiro on June 5, 1992, the solution adopted must also abide by the principles established in that Agreement.

SECOND.- In negotiating the terms of access contracts to genetic resources that originated in more than one Member Country or to their by-products and in carrying out activities connected with that access, the Competent National Authority shall bear in mind the interests of the other Member Countries, which may present their viewpoints and such information as they deem advisable.

THIRD.- The Board, through a Resolution and after hearing the opinion of the Andean Committee on Genetic Resources, may execute or adjust the procedure stipulated in Title V, Chapters I and II of this Decision.

FOURTH.- This Decision shall become effective on the date of its publication in the Official Newspaper of the Cartagena Agreement.

TEMPORARY PROVISIONS

FIRST.- On the date this Decision enters into force, those which possess, for purposes of access, genetic resources originated in the Member Countries, their by-products or associated intangible components, shall negotiate that access with the Competent National Authority pursuant to the provisions of this Decision. Accordingly, the Competent National Authorities shall set the time limits, which cannot exceed twenty-four months as of the date this Decision becomes effective.

Until this requirement is fulfilled, the Member Countries may disqualify such persons, as well as the institutions they represent or on whose account they act, from applying for new accesses to genetic resources or their by-products in the Subregion. This does not preclude the application of such sanctions as are in order once the time limit referred to in the previous paragraph expires.

SECOND.- Contracts or agreements signed by Member Countries or their public or State institutions with third parties in regard to genetic resources, their by-products, the biological resources containing them or associated intangible components, that are not in conformity with this Decision, may be renegotiated or may fail to be renewed, as applicable.

The renegotiation of such contracts or agreements, as well as the signing of new ones, shall be accomplished by common agreement among the Member Countries. To this end, the Andean Committee on Genetic Resources shall establish the common criteria.

THIRD.- The Member Countries may take such legal action as they deem advisable for the repossession of genetic resources of which they are the countries of origin, their by-products and the associated intangible components and for the collection of any damages and compensation to which they are entitled.

Only the State has the legal entitlement to the action for repossession of those genetic resources and their by-products.

FOURTH.- The Board, through a Resolution and after hearing the opinion of the Andean Committee on Genetic Resources, shall establish the necessary systems for the identification and packing of the genetic resources and, if applicable, their by-products.

FIFTH.- Within a period of no more than 30 working days after this Decision enters into force, the Member Countries shall designate the Competent National Authority on access to genetic resources and shall accredit it before the Board.

SIXTH.- The Member Countries, within a period of no more than 30 working days after this Decision enters into force, shall accredit before the Board their representatives to the Andean Committee on Genetic Resources.

SEVENTH.- The Member Countries shall adopt a common regime on biosecurity within the framework of the Agreement on Diversity. To that end, the Member Countries, in coordination with the Board, shall start the respective studies, particularly with regard to the cross-border movement of modified live organisms produced by biotechnology.

EIGHTH.- The Board shall draw up, within a period of three months after the Member Countries present their national studies, a proposal to establish a special regime or a harmonization regulation, as applicable, aimed at reinforcing the protection of know-how, innovations and traditional practices of native, Afro-American and local communities, in keeping with the provision of Article 7 of this Decision, ILO Convention 169 and the Agreement on Biological Diversity.

To that end, the Member Countries should present their respective national studies during the year after this Decision enters into effect.

NINTH.- The Member Countries shall design a training program to strength the capacity of the native, Afro-American and local communities to negotiate the intangible component within the context of access to genetic resources.

TENTH.- The Board, through a Resolution, shall adopt the reference models for the application for access to genetic resources and the access contract, within a period of no more than fifteen days after this Decision comes into effect.

Signed in the city of Caracas, Venezuela on the second of July of nineteen ninety-six.

APPENDIX D

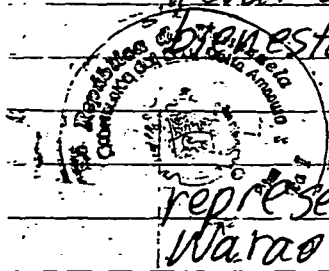
Letter of support from the Winikina Warao.

14/2/99



Al Ministerio del Ambiente
 Como los habitantes de la comunidad
 indígena Warao y Nabasankuka I del
 estado Delta Amacuro estamos de acuerdo
 con el proyecto titulado "La Etnobotánica
 de los Warao con un enfoque en sus plantas
 cicatrizantes" del Lic. Alfredo Gomez-Beloz
 que se llevará a cabo en la región (7°05'-9°45'N
 61°10'-61°20'W)

Hacemos la presente solicitud
 para que se le conceda el permiso para
 llevar a cabo este proyecto en pro de la
 bienestar de la población indígena Warao.



Atentamente firmamos los cuerpos
 representantes de la comunidad indígena
 Warao

Respetosamente,

Comisario: Trencio Reinoso Fijo 5234662

Concejal: Enrique Masalede Fijo 52356

Educador: Eugenio Plo, Fijo 52347

Enfermero: Isidoro J. Masalede Fijo 52347

Educador: Basilio Amante Fijo 5334452

Agente rural: Juan Calderón Fijo 5234663

Legajo
10.240

- 6c.i. ¿Para qué se usa la flor?
- 6d. ¿Se usa la concha? Sí o NO
- 6d.i. ¿Para qué se usa la concha?
- 6e. ¿Se usa la raíz? Sí o NO
- 6e.i. ¿Para qué se usa la raíz?
- 6f. ¿Tiene otro uso el mango? Sí o NO
- 6f.i. ¿Que otro uso tiene el mango?
7. ¿Conoces al **usiru**? Sí o NO *(Si es NO, pasa a la Pgta. 8)*
- 7a. ¿Se usa la hoja? Sí o NO
- 7a.i. ¿Para qué se usa la hoja?
- 7b. ¿Se usa la fruta? Sí o NO
- 7b.i. ¿Para qué se usa la fruta?
- 7c. ¿Se usa la flor? Sí o NO
- 7c.i. ¿Para qué se usa la flor?
- 7d. ¿Se usa la concha? Sí o NO
- 7d.i. ¿Para qué se usa la concha?
- 7e. ¿Se usa la raíz? Sí o NO
- 7e.i. ¿Para qué se usa la raíz?
- 7f. ¿Tiene otro uso el usiru? Sí o NO
- 7f.i. ¿Que otro uso tiene el usiru?
8. ¿Conoces al **hemuru**? Sí o NO *(Si es NO, pase a la Pgta. 9)*
- 8a. ¿Se usa la hoja? Sí o NO
- 8a.i. ¿Para qué se usa la raíz?
- 8b. ¿Se usa la fruta? Sí o NO
- 8b.i. ¿Para qué se usa la raíz?
- 8c. ¿Se usa la flor? Sí o NO
- 8c.i. ¿Para qué se usa la raíz?

- 8d. ¿Se usa la concha? Sí o NO
 8d.i. ¿Para qué se usa la raíz?
- 8e. ¿Se usa la raíz? Sí o NO
 8e.i. ¿Para qué se usa la raíz?
- 8f. ¿Tiene otro uso el hemuru? Sí o NO
 8f.i. ¿Que otro uso tiene el usiru?

9. ¿Conoces al idu? Sí o NO (Si es NO, pase a la Pgta. 10)

- 9a. ¿Se usa la hoja? Sí o NO
 9a.i. ¿Para qué se usa la hoja?
- 9b. ¿Se usa la fruta? Sí o NO
 9b.i. ¿Para qué se usa la fruta?
- 9c. ¿Se usa la flor? Sí o NO
 9c.i. ¿Para qué se usa la flor?
- 9d. ¿Se usa la concha? Sí o NO
 9d.i. ¿Para qué se usa la concha?
- 9e. ¿Se usa la raíz? Sí o NO
 9e.i. ¿Para qué se usa la raíz?
- 9f. ¿Tiene otro uso el idu? Sí o NO
 9f.i. ¿Que otro uso tiene el idu?

10. ¿Conoces al homoarao? Sí o NO (Si es NO, pase a la Pgta. 11)

- 10a. ¿Se usa la hoja? Sí o NO
 10a.i. ¿Para qué se usa la hoja?
- 10b. ¿Se usa la fruta? Sí o NO
 10b.i. ¿Para qué se usa la fruta?
- 10c. ¿Se usa la flor? Sí o NO
 10c.i. ¿Para qué se usa la flor?
- 10d. ¿Se usa la concha? Sí o NO

10d.i. ¿Para qué se usa la concha?

10e. ¿Se usa la raíz? SÍ o NO

10e.i. ¿Para qué se usa la raíz?

10f. ¿Tiene otro uso el homoarao? SÍ o NO

10f.i. ¿Que otro uso tiene el homoarao?

11. ¿Conoces al **sibu**? SÍ o NO *(Si es NO, pase a la Pgta. 12)*

11a. ¿Se usa la hoja? SÍ o NO

11a.i. ¿Para qué se usa la hoja?

11b. ¿Se usa la fruta? SÍ o NO

11b.i. ¿Para qué se usa la fruta?

11c. ¿Se usa la flor? SÍ o NO

11c.i. ¿Para qué se usa la flor?

11d. ¿Se usa la concha? SÍ o NO

11d.i. ¿Para qué se usa la concha?

11e. ¿Se usa la raíz? SÍ o NO

11e.i. ¿Para qué se usa la raíz?

11f. ¿Tiene otro uso el sibu? SÍ o NO

11f.i. ¿Que otro uso tiene el sibu?

12. ¿Conoces al **ohoru**? SÍ o NO *(Si es NO, pase a la Pgta. 13)*

12a. ¿Se usa la hoja? SÍ o NO

12a.i. ¿Para qué se usa la hoja?

12b. ¿Se usa la fruta? SÍ o NO

12b.i. ¿Para qué se usa la fruta?

12c. ¿Se usa la flor? SÍ o NO

12c.i. ¿Para qué se usa la flor?

12d. ¿Se usa la concha? SÍ o NO

12d.i. ¿Para qué se usa la concha?

- 12e. ¿Se usa la raíz? Sí o NO
 12e.i. ¿Para qué se usa la raíz?
- 12f. ¿Tiene otro uso el ohoru? Sí o NO
 12f.i. ¿Que otro uso tiene el ohoru?

13. ¿Conoces al korokororo? Sí o NO (Si es NO, pase a la Pgta. 14)

- 13a. ¿Se usa la hoja? Sí o NO
 13a.i. ¿Para qué se usa la hoja?
- 13b. ¿Se usa la fruta? Sí o NO
 13b.i. ¿Para qué se usa la fruta?
- 13c. ¿Se usa la flor? Sí o NO
 13c.i. ¿Para qué se usa la flor?
- 13d. ¿Se usa la concha? Sí o NO
 13d.i. ¿Para qué se usa la concha?
- 13e. ¿Se usa la raíz? Sí o NO
 13e.i. ¿Para qué se usa la raíz?
- 13f. ¿Tiene otro uso el korokororo? Sí o NO
 13f.i. ¿Que otro uso tiene el korokororo?

14. ¿Conoces al nasinaba? Sí o NO (Si es NO, pase a la Pgta. 15)

- 14a. ¿Se usa la hoja? Sí o NO
 14a.i. ¿Para qué se usa la hoja?
- 14b. ¿Se usa la fruta? Sí o NO
 14b.i. ¿Para qué se usa la fruta?
- 14c. ¿Se usa la flor? Sí o NO
 14c.i. ¿Para qué se usa la flor?
- 14d. ¿Se usa la concha? Sí o NO
 14d.i. ¿Para qué se usa la raíz?
- 14e. ¿Se usa la raíz? Sí o NO

14e.i. ¿Para qué se usa la raíz?

14f. ¿Tiene otro uso el nasinaba? SÍ o NO

14f.i. ¿Que otro uso tiene el nasinaba?

15. ¿Conoces al **bihibihidu**? SÍ o NO *(Si es NO, pase a la Pgta. 16)*

15a. ¿Se usa la hoja? SÍ o NO

15a.i. ¿Para qué se usa la raíz?

15b. ¿Se usa la fruta? SÍ o NO

15b.i. ¿Para qué se usa la raíz?

15c. ¿Se usa la flor? SÍ o NO

15c.i. ¿Para qué se usa la raíz?

15d. ¿Se usa la concha? SÍ o NO

15d.i. ¿Para qué se usa la raíz?

15e. ¿Se usa la raíz? SÍ o NO

15e.i. ¿Para qué se usa la raíz?

15f. ¿Tiene otro uso el bihibihidu? SÍ o NO

15f.i. ¿Que otro uso tiene el bihibihidu?

16. ¿Conoces al **iburu**? SÍ o NO *(Si es NO, pase a la Pgta. 17)*

16a. ¿Se usa la hoja? SÍ o NO

16a.i. ¿Para qué se usa la hoja?

16b. ¿Se usa la fruta? SÍ o NO

16b.i. ¿Para qué se usa la fruta?

16c. ¿Se usa la flor? SÍ o NO

16c.i. ¿Para qué se usa la flor?

16d. ¿Se usa la concha? SÍ o NO

16d.i. ¿Para qué se usa la concha?

16e. ¿Se usa la raíz? SÍ o NO

16e.i. ¿Para qué se usa la raíz?

16f. ¿Tiene otro uso el iburu? SÍ o NO

16f.i. ¿Que otro uso tiene el iburu?

17. ¿Conoces al **kuahineru**? SÍ o NO *(Si es NO, pase a la Pgta. 18)*

17a. ¿Se usa la hoja? SÍ o NO

17a.i. ¿Para qué se usa la hoja?

17b. ¿Se usa la fruta? SÍ o NO

17b.i. ¿Para qué se usa la fruta?

17c. ¿Se usa la flor? SÍ o NO

17c.i. ¿Para qué se usa la flor?

17d. ¿Se usa la concha? SÍ o NO

17d.i. ¿Para qué se usa la concha?

17e. ¿Se usa la raíz? SÍ o NO

17e.i. ¿Para qué se usa la raíz?

17f. ¿Tiene otro uso el kuahineru? SÍ o NO

17f.i. ¿Que otro uso tiene el kuahineru?

18. ¿Conoces al **samariya**? SÍ o NO *(Si es NO, pase a la Pgta. 19)*

18a. ¿Se usa la hoja? SÍ o NO

18a.i. ¿Para qué se usa la hoja?

18b. ¿Se usa la fruta? SÍ o NO

18b.i. ¿Para qué se usa la fruta?

18c. ¿Se usa la flor? SÍ o NO

18c.i. ¿Para qué se usa la flor?

18d. ¿Se usa la concha? SÍ o NO

18d.i. ¿Para qué se usa la concha?

18e. ¿Se usa la raíz? SÍ o NO

18e.i. ¿Para qué se usa la raíz?

18f. ¿Tiene otro uso el samariya? SÍ o NO

18f.i. ¿Que otro uso tiene el kuahineru?

19. ¿Conoces al **anare**? **SÍ o NO** *(Si es NO, pase a la Pgta. 20)*

19a. ¿Se usa la hoja? **SÍ o NO**

19a.i. ¿Para qué se usa la flor?

19b. ¿Se usa la fruta? **SÍ o NO**

19b.i. ¿Para qué se usa la flor?

19c. ¿Se usa la flor? **SÍ o NO**

19c.i. ¿Para qué se usa la flor?

19d. ¿Se usa la concha? **SÍ o NO**

19d.i. ¿Para qué se usa la flor?

19e. ¿Se usa la raíz? **SÍ o NO**

19e.i. ¿Para qué se usa la flor?

19f. ¿Se usa el cogollo? **SÍ o NO**

19f.i. ¿Para qué se usa la flor?

19g. ¿Tiene otro uso el anare? **SÍ o NO**

19g.i. ¿Que otro uso tiene el anare?

20. ¿Conoces al **winamoru**? **SÍ o NO** *(Si es NO, pase a la Pgta. 21)*

20a. ¿Se usa la hoja? **SÍ o NO**

20a.i. ¿Para qué se usa la hoja?

20b. ¿Se usa la fruta? **SÍ o NO**

20b.i. ¿Para qué se usa la fruta?

20c. ¿Se usa la flor? **SÍ o NO**

20c.i. ¿Para qué se usa la flor?

20d. ¿Se usa la concha? **SÍ o NO**

20d.i. ¿Para qué se usa la concha?

20e. ¿Se usa la raíz? **SÍ o NO**

20e.i. ¿Para qué se usa la raíz?

- 20f. ¿Se usa el cogollo? Sí o NO
 20f.i. ¿Para qué se usa la cogollo?
- 20g. ¿Tiene otro uso el winamoru? Sí o NO
 20g.i. ¿Que otro uso tiene el winamoru?

21. ¿Conoces a la **yaha**? Sí o NO *(Si es NO, pase a la Pgta. 22)*

- 21a. ¿Se usa la hoja? Sí o NO
 21a.i. ¿Para qué se usa la raíz?
- 21b. ¿Se usa la fruta? Sí o NO
 21b.i. ¿Para qué se usa la raíz?
- 21c. ¿Se usa la flor? Sí o NO
 21c.i. ¿Para qué se usa la raíz?
- 21d. ¿Se usa la concha? Sí o NO
 21d.i. ¿Para qué se usa la raíz?
- 21e. ¿Se usa la raíz? Sí o NO
 21e.i. ¿Para qué se usa la raíz?
- 21f. ¿Se usa el cogollo? Sí o NO
 21f.i. ¿Para qué se usa la raíz?
- 21g. ¿Tiene otro uso el yaha? Sí o NO
 21g.i. ¿Que otro uso tiene la yaha?

22. ¿Conoces al ohidu? Sí o NO *(Si es NO, pase a la Pgta. 23)*

- 22a. ¿Se usa la hoja? Sí o NO
 22a.i. ¿Para qué se usa la hoja?
- 22b. ¿Se usa la fruta? Sí o NO
 22b.i. ¿Para qué se usa la fruta?
- 22c. ¿Se usa la flor? Sí o NO
 22c.i. ¿Para qué se usa la flor?
- 22d. ¿Se usa la concha? Sí o NO

- 22d.i. ¿Para qué se usa la concha?
- 22e. ¿Se usa la raíz? Sí o NO
- 22e.i. ¿Para qué se usa la raíz?
- 22f. ¿Se usa el cogollo? Sí o NO
- 22f.i. ¿Para qué se usa la cogollo?
- 22g. ¿Tiene otro uso el ohidu? Sí o NO
- 22g.i. ¿Que otro uso tiene el ohidu?
- 23. ¿Conoces al murusi? Sí o NO (Si es NO, pase a la Pgta. 24)**
- 23a. ¿Se usa la hoja? Sí o NO
- 23a.i. ¿Para qué se usa la hoja?
- 23b. ¿Se usa la fruta? Sí o NO
- 23b.i. ¿Para qué se usa la fruta?
- 23c. ¿Se usa la flor? Sí o NO
- 23c.i. ¿Para qué se usa la flor?
- 23d. ¿Se usa la concha? Sí o NO
- 23d.i. ¿Para qué se usa la concha?
- 23e. ¿Se usa la raíz? Sí o NO
- 23e.i. ¿Para qué se usa la raíz?
- 23f. ¿Tiene otro uso el murusi? Sí o NO
- 23f.i. ¿Que otro uso tiene el murusi?

Ahora te voy hacer unas preguntas sobre tu uso de servicios médicos.

24. ¿Cuántos años tienes? _____

25. ¿Alguna vez en el pasado has acudido a un...

25a. **doctor?** _____

25b. **wisiratu?** _____

25c. **hoarotu?** _____

25d. **bahanarotu?** _____

26. ¿Alguna vez has ido a . . .

26a. **Nabasanuka Medicatura** para atención médica? **SÍ o NO**

26b. **Guayo Medicatura** para atención médica? **SÍ o NO**

26c. **Tucupita Hospital** para atención médica? **SÍ o NO**

26d. **Caracas** para atención médica? **SÍ o NO**

26e. **Barrancas Hospital** para atención médica? **SÍ o NO**

Eso es todo. Ya ha terminado todo. Gracias.

APPENDIX F

Ranking order of Specific Reported Uses using the total Overall Use Value (OUV).

<u>SPECIFIC REPORTED USE</u>	<u>OUV_[total]</u>	<u>PLANTS WITH REPORTED USE</u>	<u>PLANT PARTS USED (VILLAGE)⁽¹⁾</u>
eat	7.289	Anare (1.431)	frM, amM, frE, amE
		Homoarao (1.309)	frM, frE
		Winamoru (1.191)	frM, amM, frE, amE
		Mango (0.891)	frM, frE
		Usiru (0.862)	frM, frE
		Ohidu (0.855)	frM, amM, frE, amE
		Yaha (0.417)	frM, amM, frE, amE
		Iburu (0.333)	frE
grippe	4.896	Sibu (1.488)	lfM, frM, bkM, lfE, frE, fwE, bkE
		Nasinaba (0.924)	frM, bkM, lfE, frE, bkE
		Murusi (0.730)	lfM, frM, bkM, rtM, otM, lfE, fwE, bkE, rtElfM, bkM, bkE
		Korokororo (0.726)	lfM, frM, amM, frE, amE
		Yaha (0.667)	frM, frE
		Homoarao (0.310)	lfE
		Usiru (0.051)	
diarrhea	2.238	Usiru (0.745)	lfM, bkM, lfE, bkE, rtE
		Idu (0.455)	lfE, fwE, bkE
		Bihibihidu (0.333)	bkM
		Mango (0.321)	frM, bkM, lfE, bkE, rtE
		Nasinaba (0.120)	frM, lfE, frE
		Anare (0.107)	bkM, otM
		Sibu (0.090)	lfE, bkE
		Iburu (0.067)	bkE

SPECIFIC REPORTED USE	OUV_[total]	PLANTS WITH REPORTED USE	PLANT PARTS USED (VILLAGE)⁽¹⁾
wound	1.569	Ohoru (0.930)	bkM, bkE, rtE
		Mango (0.132)	lfM, bkM
		Bihibihidu (0.111)	bkM
		Iburu (0.067)	bkM
		Anare (0.064)	bkM
		Korokororo (0.053)	frM
		Ohidu (0.037)	bkM
		Usiru (0.031)	bkM
canoe	1.407	Samariya (0.763)	otM, bkE, rtE, otE
		Ohoru (0.553)	otM, bkE, rtE, otE
		Idu (0.091)	otE
bleach	1.300	Kuahineru	frM, lfE, frE, otE
fever	1.222	Korokororo (0.621)	bkM, lfE, bkE
		Idu (0.182)	frE, bkE
		Nasinaba (0.100)	lfM, lfE, frE
		Murusi (0.089)	lfM, lfE, bkE
		Ohoru (0.077)	lfE
		Homoarao (0.071)	bkE
		Sibu (0.045)	bkE
		Ohidu (0.037)	lfM
mouth sore	1.117	Kuahineru (0.700)	bkM, bkE
		Iburu (0.400)	bkM, bkE
		Yaha (0.017)	lfM

SPECIFIC REPORTED USE	OUV_[total]	PLANTS WITH REPORTED USE	PLANT PARTS USED (VILLAGE)⁽¹⁾
to give fruit	0.832	Usiru (0.108) Idu (0.091) Mango (0.091) Winamoru (0.086) Ohoru (0.077) Homoarao (0.071) Nasinaba (0.070) Anare (0.064) Murusi (0.060) Korokororo (0.050) Yaha (0.038) Ohidu (0.026)	fwM, fwE fwE fwM, fwE fwM, fwE frE fwE fwM, fwE fwM, fwE fwM, fwE fwE fwM, fwE fwM, fwE
dye	0.785	Murusi	frM, frE
diarrhea & blood	0.766	Bihibihidu (0.611) Iburu (0.134) Anare (0.021)	bkM, bkE bkM, bkE rtE
firewood	0.727	Bihibihidu (0.611) Iburu (0.071) Sibu (0.045)	bkM, otE rtE rtE
fish bait	0.716	Hemuru (1.66) Homoarao (0.056)	frM, fwM, frE, fwE fwM
canoe to bury person	0.691	Idu	otM, otE
honey	0.677	Iburu	frM, fwM, frE, fwE, bkE
wina	0.652	Winamoru	bkM, otM, amM, fwE, bkE, amE
house (roof, wall)	0.637	Yaha	lfM, lfE
flat sawn boards	0.573	Samariya (0.277) Korokororo (0.205) Ohoru (0.091)	otM, bkE, otE otM, rtE, otE otM
oar	0.431	Samariya	bkM, otM, bkE, otE

SPECIFIC REPORTED USE	OUV _[total]	PLANTS WITH REPORTED USE	PLANT PARTS USED (VILLAGE) ⁽¹⁾
fever & grippe	0.403	Nasinaba (0.180) Murusi (0.120) Korokororo (0.103)	lfM, frM, frE, bkE bkM, rtM, lfE, rtE bkM, lfE
toy canoe	0.397	Korokororo (0.203) Iburu (0.138) Hemuru (0.056)	bkM, frE, rtE bkM, otE otM
injury	0.396	Mango	lfM, bkM, lfE, fwE, bkE
toothache	0.332	Idu (0.200) Iburu (0.067) Sibu (0.046) Mango (0.019)	bkM bkM bkM rtM
protection against <i>hebu</i>	0.331	Idu (0.291) Nasinaba (0.040)	bkM, fwE frM
hammock	0.284	Ohidu	lfM, lfE
fever & catarrh	0.239	Korokororo (0.150) Nasinaba (0.060) Murusi (0.029)	lfE, bkE lfE, frE lfE
stingray wound	0.221	Samariya	bkM, bkE
yuruma	0.221	Ohidu	bkM, otM, bkE, otE
house in morichal	0.215	Ohidu	lfM, bkM, otM, lfE
house floor	0.213	Anare	bkM, otM, bkE, rtE, otE
fever & diarrhea	0.177	Nasinaba (0.100) Murusi (0.029) Mango (0.027) Yaha (0.021)	frM, frE, bkE lfE lfE frE
folk basket	0.174	Ohidu	lfM, lfE
necklace	0.155	Nasinaba (0.110) Sibu (0.045)	frM, frE bkE
table	0.154	Samariya	otM

SPECIFIC REPORTED USE	OUV_[total]	PLANTS WITH REPORTED USE	PLANT PARTS USED (VILLAGE)⁽¹⁾
diarrhea & grippe	0.141	Nasinaba (0.070) Korokororo (0.050) Yaha (0.021)	frM, frE bkE frE
vomiting	0.141	Nasinaba (0.110) Usiru (0.031)	frM, frE frM
bathe child	0.125	Korokororo (0.106) Mango (0.019)	lfM, bkM lfM
snake bite	0.123	Homoarao (0.111) Ohidu (0.012)	bkM bkM
cold	0.114	Yaha (0.071) Winamoru (0.043)	frM, amM, frE rtM
catarrh	0.112	Sibu (0.091) Yaha (0.021)	bkE amE
wasp sting	0.112	Hemuru	lfM, otM
diarrhea & green stool	0.111	Bihibihidu	bkM
feeling bad	0.111	Bihibihidu	bkM
fishing	0.111	Hemuru	lfM
intestinal worms	0.111	Bihibihidu	bkM
prevent illness	0.102	Murusi (0.062) Nasinaba (0.040)	lfM, bkM bkM
newborn	0.094	Murusi	lfM, bkM
diarrhea & vomiting	0.083	Usiru	bkM, lfE, bkE
grippe, catarrh, fever	0.071	Homoarao	frE
diarrhea & intestinal worms	0.067	Iburu	bkM
lining of basket	0.063	Hemuru	lfE
scabies	0.053	Korokororo	bkM

SPECIFIC REPORTED USE	OUV_[total]	PLANTS WITH REPORTED USE	PLANT PARTS USED (VILLAGE)⁽¹⁾
maggots from bark to eat	0.052	Ohidu	otM, otE, amE
fever, diarrhea, all illness	0.050	Korokororo	bkE
quench thirst	0.048	Mango (0.027) Anare (0.021)	otE otM
fever & headache	0.046	Sibu	bkM
fever, diarrhea, grippe	0.046	Sibu	bkM
fever, headache, cough	0.045	Sibu	bkE
headache	0.031	Mango (0.019) Ohidu (0.012)	lfM lfM
fever, grippe, catarrh	0.030	Nasinaba	frE
all use	0.026	Usiru	lfE
calm pain	0.026	Usiru	bkE
sick child	0.026	Usiru	lfE
bad cold	0.021	Yaha	amE
boardwalk	0.021	Anare	otM
childbirth	0.021	Anare	bkM
diarrhea & catarrh	0.021	Yaha	amE
give to small baby	0.021	Yaha	amE
sell for food	0.021	Anare	amE
bathe mother	0.019	Mango	bkM
makes flower	0.019	Mango	lfM
scabies wound	0.019	Mango	bkM
use to carry things	0.017	Yaha	frM

SPECIFIC REPORTED USE	OUV_[total]	PLANTS WITH REPORTED USE	PLANT PARTS USED (VILLAGE)⁽¹⁾
buoy	0.014	Ohidu	rtE
bow	0.012	Ohidu	lfM
toy	0.012	Ohidu	frM
water	0.012	Ohidu	bkM

⁽¹⁾ lf = leaf, fr = fruit, fw = flower, bk = bark, rt = root, ot = other, am = apical meristem;
M = Morichitos, E = España.

APPENDIX G

Acceptance letter of *in vivo* bioassay protocol from the *Instituto Venezolano de Investigaciones Científicas* Uso de Animales.



Altos de Pipe, 23 de Febrero de 1.999

Dr.
James S. Miller
Applied Research Department
Missouri, Botanical Garden
P.O. Box. 299
St. Louis, Missouri 63166-0299
U.S.A.

Estimado Dr. Miller:

El protocolo presentado por el Lic. Alfredo Gómez-Beloz para la utilización de Ratas Sprague Dawley de 150-200 g. en el estudio: "La etnobotánica de los Warao con un enfoque en sus plantas cicatrizantes", cumple con las Normas para el Uso y Cuidado de los Animales de Laboratorio, considerándose apropiada la técnica quirúrgica así como el tratamiento pre y post-operatorio que recibirán los animales usados como biomodelos.

Los bioensayos serán realizados bajo la dirección del Dr. Fabián Michelangeli, Jefe del Laboratorio de Fisiología Gastro-Intestinal de este Instituto.

Estando conforme los procedimientos, se autoriza el uso de las ratas Sprague Dawley solicitadas.

Atentamente,


Dr. Ernesto Candela V.
Jefe Bioterio - IVIC.



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AUTOBIOGRAPHICAL STATEMENT

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