FINAL REPORT, 1979 FIELD SEASON, CIHUATAN, EL SALVADOR: BOTANICAL INVESTIGATIONS

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I. Introduction

The botanical aspect of Cihuatan field studies actually began in 1975 with a series of conversations that took place between the leader of the project, Jane H. Kelley, and the original botanist of the project, Annita Harlan, then a doctoral student at The University of Arizona, Tucson. In the summer of 1975, trade routes and the source-sink patterns of economic goods were under discussion in the context of Kelley's field work in the Bonito Valley, New Mexico. It was agreed that excavations took on new dimensions and coloring if evidence from the natural and physical sciences are focused on archaeological puzzles in an integrated way. A holistic approach, apart from being a fad, could provide intellectually satisfying answers to the distribution, apparent actions, and artifactual preferences of archaeologically known peoples. An interdisciplinary, multidisciplinary approach which could involve several specialists in non-archaeological fields was thought to be desirable. Harlan had experience with this kind of team effort. As a result, she was included when Kelley initiated plans for her work at Cihuatan and elected to draw in several non-archaeologists.

A further corollary of the interdisciplinary experiment developed partly because of logistic difficulties during the late planning stages. It was finally decided to use three botanists, not one, each serving a one-month tour of duty and overlapping in such a way that much of the time two botanists were in residence at Cihuatan simultaneously. This was to provide a factor usually absent, and very much needed, in interdisciplinary field work, intradisciplinary review as work progresses. Since the members of the team had complementary interests, their stays at Cihuatan were ordered to take advantage of these. Van Asdall, an ecologist and ethnobotanist, participated in the initial stages of the dig when survey and orientation were being carried out. By the time excavation was well underway, Miksicek arrived to take charge of flotation. Harlan was then involved in the wrapping-up phase of the season.

From the archaeological point of view, the botanists were being asked to uncover the probable economic base of what was presumed to be an agrarian society. Additionally, since the thrust of the investigation was to deal with intrasite variability, the definition and probable uses of microhabitats (and accompanying microclimates) within the site were of great interest. It was also thought that simply by living and working within the area, the natural scientists might make serendipitous observations which would stimulate the interpretive process for the archaeologists.

More specifically, certain hypotheses were to be examined and tested if possible. Many of these had been raised by previous investigators, particularly Karen Bruhns:

- Could pollen analysis yield subsistence or climatic data at Cihuatan?
- Could analyzable botanical remains be recovered by flotation?
- Which hallucinogenic barks occur in the area? Could these have been important in Maya life and trade?
- Could the economic basis of Cihuatan have been a cash crop, like cacao?
- Could different areas of the site with microclimatic differences have been used for the growing of different crops?

It is a credit to the vision and non-territoriality of Canada Research Council that they saw fit to allow an investigator from the University of Calgary to assemble and deploy a multinational, multidisciplinary team to conduct research in Central America. We thank them for the opportunity to participate.

Before proceeding with the remaining sections of the report, it seems appropriate to place Cihuatan within the larger setting of Central America.

Although the political unit we now recognize as Central America forms a narrow physical land connection between North and South America, this is a relatively recent development. During most of the Cretaceous, about 3,000 km separated the two land masses. About 80 million years ago, a general uplift resulted in northern Central America and the northern Andes beginning to approach their modern configuration, with a direct land connection being established about 5.7 million years ago (Raven and Axelrod, 1975:422). Because "sweepstakes dispersal" between the two land masses occurred before a land connection was established, and "rapid direct dispersal" occurred afterward, there is a remarkable uniformity in the biota of Latin America--from Mexico to Argentina. A widely accepted interpretation of this phenomenon, taking into account recent advances in plate tectonics and continental movements, is summarized in Raven and Axelrod (1975). By correlating time of separation of Africa and South America, length of time they were reasonably close before South America drifted to its present position, and rates of evolution of certain taxa, they explain taxonomic similarities and differences between South (and Central) America and Africa. Thus, rainforests and seasonally dry tropical forests in Africa bear striking structural and compositional resemblances to those in the Americas.

Because topography in Central America varies from extensive lowland through mid-elevational upland to mountain peaks, and because the climatic factors, especially barometric pressure and marine currents, are different from the Caribbean to the Pacific sides, a remarkable range of climate, and hence of vegetation, exists within the confines of this relatively small political unit. Generally, the Caribbean side enjoys a more continuous distribution of annual rainfall and thus a more continuous distribution of tropical rainforest than the Pacific side. Because Panama is a narrow strip, climatic and vegetational differences between its two sides are minimal. Northward, the land widens, with increasing differences on the western and eastern sides at the same latitude. These differences become more pronounced where rugged high elevational terrain occurs in the interior, such uplifts being generally more common as the land mass widens northward. As a result, on the Pacific side, there is a fairly continuous distribution of dry tropical forests—Semi-Humid Deciduous Tropical Forest or Monsoon Forest of some authors (see Beard, 1944 and 1955 for a discussion of the classification of tropical vegetation). Because of recent, fairly efficient dispersal of flora between the contiguous American land masses, vegetation types would appear quite similar in South and Central America, at least regarding species presence, if not abundance, dispersion, and diversity. An interesting recent study (Hubbell, 1979) analyzes these vegetational parameters for a tropical dry forest in Costa Rica, but more work is needed to determine the extent of similarity throughout Latin America.

Jorge A. Lagos (1973), Professor of Pharmacy and Agronomy at the National University of El Salvador, has published a general account of the vegetational zones of that country. He recognizes three major climatic zones with corresponding differences in vegetation. The Tierra Caliente or Hot Land (sea level to about 500 m), exhibits four general subdivisions. There are upland, e.g. hills, ridges, and lowland, e.g. floodplains, valley, in both the lower and upper elevational reaches (but hilly terrain in the lower Tierra Caliente is limited). True tropical rainforest elements are found in the lowland phases where ground water is abundant during the extended dry season. Since Cihuatan is located in the Tierra Caliente, an idea of its vegetation can be obtained by referring to the Results section of this report which deals in part with the plant geography of the Cihuatan area. The Tierra Templada occurs at a higher elevation and is dominated by pines and oaks. The last zone, the Tierra Fria, is found in the highest elevations in El Salvador. Especially where enshrouded in perpetual fog, these regions support a cloud forest with temperate as well as tropically derived elements.

Small areas with similar vegetation occur northward into Durango, Mexico (farthest extension on the Pacific side of cloud forest), and into Nayarit, Mexico (supporting some tropical-deciduous forest with rainforest elements). In southern Mexico, thorn forest and tropical scrub vegetation types become increasingly more important than they are further south, largely in response to a weakening of the "monsoonal" regime, reduced total precipitation and more pronounced atmospheric aridity.

II. Methodology

Introduction

The botanical team was assembled two months before departure for El Salvador. Although we were able to locate several botanical references for El Salvador and more for adjacent countries, we were unable to obtain them. Thus the botanists arrived in El Salvador without one of their basic tools—reference works with taxonomic keys.

At the inception of work in early June it was apparent that two basic activities needed immediate attention:

1) Since the peak flowering and fruiting season was past, it was desirable to become involved with field work and to get the modern collections underway.

2) Because we did not have botanical reference works in our possession, it was desirable to visit bookstores and libraries and to start contacting interested professionals who could be of help in orientation and plant identification.

Professional Contacts and Facilities

Between arriving in San Salvador and departing for Cihuatan, we visited Alfredo Ortiz, Head, and Stanley Boggs, Chief Archaeologist, Patrimonio Cultural.

Both have detailed knowledge of the workings of governmental organizations and other institutions in El Salvador. They suggested a number of professional people and organizations to us and we contacted some of them during the season:

Robert A. Simms, Instituto Geográfico Nacional, San Salvador, provided access to maps of the Cihuatan and surrounding area.

Vilma Ethel de Castro, Facultad de Ciéncias Agronómicas, Universidad Nacional de El Salvador, discussed traditional agriculture in El Salvador with us and suggested locations for historical documents.

Victor Hellebuyck, Head, and Rosa Nońemy Tobar de Sahueron, Museo de Historia Natural de El Salvador, San Salvador, provided access to plant and animal collections and suggested additional professional contacts.

Jorge A. Lagos, Facultad de Farḿacia and Facultad de Ciéncias Agronómicas, Universidad Nacional de El Salvador, aided with identification of difficult plant specimens, provided access to his herbarium for comparative purposes, provided laboratory facilities and materials for pollen extraction, and supplied us with much interesting and valuable botanical and environmental information during our several visits. He is our main botanical contact.

Time and circumstances did not permit us to contact:

Francisco Serrano, Ecologist, Ministerio de Agricultura, Dirección de Ganadaría, Forest de Montecristo, Dirección de Recursos Naturales, near San Salvador.

Dennis Witsberger and María Luisa Reńe de Aguilar, both working with Sr. Serrano at the Ministerio de Agricultura.

CENTA, a large agricultural experimental facility north of San Salvador.

Library Resources

Early in the season we were able to purchase or obtain free of charge several useful books and bulletins from the bookstore at the Museo Nacional, the University bookstore, and the University Publication Office, including:

Guzman, David J. (1918 and 1926)

Lagos, Jorge A. (1973)

Choussy, Felix (1975, 1976, 1977, and 1978)

Flora y Fauna, Año 2, Nos. 2 y 3; Año 3, No. 4

Toledo, Judith and Gustavo Escabar (197)

According to Prof. Lagos, the University Library has a copy of Standley's Flora of El Salvador, but it is in the reference collection and must be used there, which is impractical for keying of collected specimens.

Later in the season we were able to visit the library at the Museo Nacional and examine documents containing ethnohistorical material. Because of lack of time, we looked only briefly at the following:

Squier, F.G. (MDCCLX)

Larde y Larin (1957)

Excavation, Pollen, and Flotation

Excavation methods and procedures can be found in Kelley's report of the 1979 Field Season at Cihuatan.

Two soil samples were taken from appropriate proveniences in Excavation Unit I, Structure A. Prof. Jorge A. Lagos, provided laboratory facilities for an unsuccessful attempt to extract pollen from them using modified heavy liquid flotation (sucrose was substituted for zinc bromide). As a result of this preliminary work, and because pollen presumably does not preserve long or well in the tropics, it was decided not to take additional soil samples for this purpose.

Numerous soil samples were taken from appropriate proveniences for flotation analysis. Methods and procedures are given in Miksicek's report on flotation.

Informants

Although we talked briefly with a number of campesinos and vendors in the mercado at Aguilares, our three main botanical/environmental informants live at or near Cihuatan. Because of earlier archaeological workers at Cihuatan, notably Karen Bruhns, William Fowler, and Richard Crane, they were already familiar with some of our needs and were eager to help. They are:

Sr. Gregorio Quijano Pérez, who knows common names and the uses of many of the local plants.

Sr. Dolores García is knowledgeable about land use and land changes, agricultural fallowing practices, etc.

Sra. Adelita Prieto Mira, owner of a nearby finca, knows many native local plants by common name and is knowledgeable about many locally used exotics, particularly medicinal plants.

Since most plants were not in the reproductive stages, having a common name for them was an invaluable aid to us and even to Prof. Lagos. It gave us a starting place in the identification process whether working with library resources or with the herbarium and other facilities at the University.

Field Studies

For our studies near Cihuatan, observations, photographs, and collections were made of the plants growing in the open habitats associated with the ruins, milpas, and pastures, and of plants found in the microhabitats along the banks of the Río Izcanal and Río Acelhaute. In addition, we studied a small woodlot and two small tracts of forest. Both forest tracts had experienced some disturbance, expecially cutting for firewood and fence posts, but the extent of disturbance was not determined. No quantitative sampling of the forests or woodlot was undertaken, because of lack of time, trained personnel for assistance, and 4-wheel drive transportation (which would facilitate travel in the Cerro de Colima).

Collections

For our modern plant collections, sufficient material was taken so that, after pressing, a standard sized herbarium sheet could be filled. When available, reproductive stages were included. Samples of wood were also collected for many species of shrubs and trees. These form the nucleus of our developing comparative collection--an assemblange of identified plants and plant parts against which unknown botanical materials from archaeological contexts can be compared.

Although a portion of the botanical materials recovered from excavations may be destroyed in the identification process, that which survives forms yet another developing collection. Project Director Kelley has requested that both of these collections be deposited and curated, at least temporarily, at The University of Arizona, Tucson.

III. Results

Phytogeography

Las Ruinas de Cihuatan, at approximately 325 m above sea level, and 50 m above the nearby recently entrenched Río Acelhuate, are located in the upper reaches of the Tierra Caliente. The ruins are situated on hilly terrain, with the ceremonial center on a broad hilltop. The soils, volcanic in origin, are thin, perhaps because of thinly deposited volcanic material, but also because of gully and sheet erosion, resulting in deeper soils in intervening valleys and other low-lying terrain. In places, poor drainage results in swales.

The hills and slopes of the site form a partial watershed divide for the two nearby streams. The Río Ishcanal heads locally, has a small watershed, and apparently has insufficient volume and cutting force to entrench at its mouth. It is a sluggish stream and the nearby fields have a bottomland character. The Río Acelhaute heads in the mountains near San Salvador, thus it has a much larger watershed and a steep gradient; during the last 30 years land clearing and sewage effluent from San Salvador have promoted entrenchment. Fields bordering this river have resultantly developed some upland hydrologic features. The Río Lempa system, about 16 km distant, had an extensive flood plain with local remnants of forest vegetation until the last five years. The Acelhuate may have resembled the Lempa prior to World War II.

Because of land clearing begun about 40 years ago, open areas have become a major habitat in the site and surroundings. Some of these seem to be relatively little managed. Most, however, are managed to a considerable extent. Upland open areas are dominantly maize milpas, or, depending upon land ownership and topography, are in pasture. Flat upland areas are sometimes used for upland rice. Low-lying areas may be used for pasture if swales are common, but more frequently are cash-crop <u>fincas</u> planted in sugarcane. The bottomland bordering the Río Ishcanal is used this way. A narrow strip immediately adjacent to the stream may be planted in produce, or left as a band of trees representative of the earlier forest vegetation. When the trees are cleared for growing of produce, and a backwater is nearby, an intergradation of wild, more or less hydrophytic plants, e.g. Araceae, <u>Heliconia</u>, chufle, etc., occurs with corn, bean, squash and several tended weeds.

Recently, the extensive cultivation of the Lempa River margins has been terminated by flooding from hydroelectric dam and reservoir developments, thereby removing from cultivation a highly productive and self-renewing land resource.

The small tract of forest or woodlot (less than 1 km^2) on land belonging to Sra. Adelita Prieto Mira had been left uncleared when large-scale forest clearing was undertaken near Cihuatan about 40 years ago. Judging from the small boles of some of the canopy trees, earlier disturbance perhaps selective cutting, had occurred. Since wood is still widely used for cooking in the villages as well as the country, and since few woodlots remain, there has undoubtedly been much illegal poaching of wood from Sra. Prieto Mira's woodlot during the past 40 years.

Examples of tree species occurring in the canopy stratum:

Calycophyllum candidissium (salamo)

Ceiba pentandra (pochote)

Enterolobium cyclocarpum (quanacaste, conacaste)

Copaifera himenefolia (quiebra-hacha)

Cedrella odorata (cedro)

Bursera simaruba

Examples of trees species occurring in the mid-stratum:

Morus celtidifolia (mora)

Pithecollobium sp. (conacaste blanco)

Erythroxylon mexicanum (coca)

Cordia alba (tiguilote)

Cochlospermum vitifolium (tecomasuche)

Acacia cornigera (cutupito)

Acacia hendsii (iscanal)

Acacia farnesiana (espino blanco)

Piper triquetum (cordoncillo)

The much larger (at least 8 km^2) forest covering the Cerro do Colima and environs (see Frontispiece) has patches which are similar to Sra. Prieto Mira's woodlot. Other, perhaps less disturbed, patches exhibit increased stratification with at least two species becoming canopy emergents:

Ficus glabrata (chilamate)

Enterolobium cyclocarpum (guanocaste, conaste)

These patches are a little more diverse in the canopy and sub-canopy. The following are examples of additional overstory species:

Bursera graveolens (jiote)

Carica papaya (wild papaya) prefers forest edge habitat and Crescentia alata (moro) is common in open areas everywhere.

Thus, the Cerro de Colima appears to be covered with a mosaic of patches of forest, differing somewhat in composition and structure as related to type, extent, how recently disturbance has occurred, and to topographic and microhabitat differences.

Microhabitats

Microhabitats are plentiful. On upland sites they include wood lots, small tracts of forest, seeps, ravines, fencerows, and rock walls. Lowland sites support different and diverse assemblages of forest species depending on variations in backwater development, steepness of banks, and amount of clearing. The steep banks of the Río Acelhuate serve as a refugium for many species of the vanished deep forest which can be seen in few areas as an integrated community nowadays.

The diversity of the local flora can be more completely appreciated by referring to the Appendix where we list the plants from all vegetation types and microhabitats studied. The list was compiled from our modern collections, photographs, field notes, and other observations.

Additional evidence for the reconstruction of the forest that existed during occupation could be obtained from several sources. More extensive field work with local informants is needed to help interpret differential uses of tree species for firewood, posts, construction, etc. Flotation can be a powerful tool, and although the results of flotation for the 1979 season yielded little information for this purpose, more extensive use of the technique in future seasons is expected to generate a greater volume of data applicable to this problem.

Flotation

Flotation data for the 1979 season suggests that pine was extensively used, possibly for construction. We hypothesize that pine was cut from the stands at

Bursera simaruba (jiote)

Tabernaemontana Donnell-Smithii (cajon de puerco)

Plumeria acutifolia (flor de Mayo, flor de la Cruz Blanca)

Cecropia peltata mexicana? (guarumo)

Additional species in the mid-level stratum include, for example:

Luehea candida (cabo de hacha)

Psidium guajava (guayabo)

Guasuma ulmifolia (caulote)

Well lighted forest floor areas are densely carpeted with chufle, contrayerba, *Commelina* sp.,*Lygonium polinorphym* and other ferns, *Selaginella* sp., and *Begonia* sp. Near ox-cart trails and at the edges of milpas and other clearing, shrubs and vines become prominent, for example:

Capsicum annum

Rivinia humilis (flor blanca)

Hamelia patens (chichipinco)

Petastoma sp. (bejuco de corral, bejuco de casa)

Desmodium sp. (bejuco capitan)

Although El Salvador has a mean annual precipitation of 2,000 mm (± 300 mm), 94% of this falls within the six month rainy season. Thus, the six month dry season is very dry (although the relative humdiity of the air is frequently high), and the rainy season is very wet. True tropical, evergreen, rainforest species cannot tolerate extended periods of low soil moisture. At Cerro de Colima rainforest elements such as the fig, *Castilla elastica* (palo de hule) and the palm, *Bactris subglobosa* (huiscoyol) are restricted to areas where drainage patterns provide a continuous supply of water for their shallow roots; for example, adjacent to semipermanent drainages, along floodplains, and near seeps and springs.

higher elevations (that is, the Tierra Templada), perhaps from the Volcan de Guazapa, and transported to the site partly overland and partly floated downstream in the Río Guazapa-Acelhuate system. Since 19% of the wood charcoal in Structure A, however, belonged to taxa other than pine, it seems a reasonable hypothesis that these had been obtained close to the site and had been used for non-construction purposes. Wood charcoal recovered from the oven in Excavation Unit 2 are from several hardwoods including Guaiacum sp. Such woods produce hotter fires than pine, giving support to the idea that the oven of Excavation 2 was used in metallurgy. Other woody taxa recovered as charcoal include Bactris (a palm), Spondias (jocote), Ficus (á fig), Brysonia (nance), and Curatella americana (chaparro). As identification of these taxa progresses, and with additional data in forthcoming seasons, the flotation technique is expected to prove an important complementary and supplementary source of information for vegetational and climatic reconstruction during occupation.

Several species of cultivated crops-the maize-beans-squash triad, cotton, indigo, cacao and cashew--were found in Excavation Unit 2, presumably a small temple. Various weedy elements, most notably beggar's lice (Desmodium sp.) escobilla (Sida sp.), flor amarilla (Baltimora recta), grasses, and morning glories occurred in both units. Tables 1 and 2 in the flotation report by Miksicek list the taxa recovered and the identifications made to date.

Artifacts and Architecture

Predictably, the largest quantity of artifacts recovered from excavations at Cihuatan was sherds. Numerous obsidian flakes were uncovered; grain milling stones and spindle whorls were also found. The sherds have not yet been analyzed in detail (nor have architectural features) so any inferences to be made from these sources will have to be deferred. Inferences for the other three artifactual types, however, deserve brief comment and will be discussed in Conclusions and Speculations.

IV. Conclusions and Speculations

Crops

Evidence that maize and cotton were processed, if not grown, at Cihuatan is suggested from a number of independent sources. The presence of artifacts for the processing of these crops--grain milling stones and spindle whorls--is circumstantial evidence, and this is reinforced with the recovery of maize grains and cupules and two of what we have tentatively identified as cotton seeds. Another source of evidence not incompatible with the foregoing comes from the descriptions of crops grown at the villages near Cihuatan in historical Spanish documents (Methodology). Maize, cotton, indigo, and sugar cane are repeatedly mentioned. Indigo grows wild in the area today and five indigo seeds and several wood fragments were recovered from flotation. We speculate that because of the availability of agricultural land on the floodplain terrain near the site, maize was grown during the wet season and cotton was grown there during the dry season.

Obsidian

Obsidian flakes could have been mounted in wooden holders to provide serrate-edged cutting tools of considerable utility in processing vegetable crops or in reducing vegetational cover, e.g. weed cutting. Regarding the suggestion that obsidian graters might have been used in the preparation of manioc roots for food, we have no evidence to support manioc use at Cihuatan. We also tend to agree with Payson Sheets' observation made at the Puleston Conference on "The History and Development of Maya Subsistence" (University of Minnesota, October 4-6, 1979). He reasoned that since obsidian fractures to a thickness of 30 microns and these slivers would become contaminants in food, any comestibles so produced would be lethally rough on the gastrointestinal tract.

Although obsidian chip usage at Cihuatan is presently uncertain, we are looking less at food preparation possibilities than at vegetation reduction.

Because the creation of the site also created an open, disturbed habitat, a rank growth of weeds, shrubs, and grass probably occurred at the time of occupation as it does today. Obsidian may have been used for cutting grass and perhaps very young shrubs and trees, all of which would have enjoyed rapid growth during the wet season. The roots of woody species can cause serious damage to and disruption of, foundations and walls if allowed to grow beyond a certain minimum size.

People-Plant Interactions

Although excavation was limited, and thus also the volume of material processed by flotation during the 1979 season, a sufficient variety of plant taxa in large enough quantity was recovered, when combined with other lines of evidence, to allow us to tentatively suggest some of the daily people-plant interactions of the Cihuatecos. See Miksicek's report for details on flotation.

Harlan and deWet (1965:18) have categorized plants on the basis of how people react to them. There are plants, for example, which are domesticated, tended, actively encouraged, ignored, discouraged, etc. Although it isn't possible to confidently state how the people of Cihuatan might have reacted to some of the plant taxa with which they came in contact, probably each category is represented.

It is safe to assume that plant taxa recovered from flotation which had been domesticated and involved in basic subsistence (e.g. maize, beans, and squash) were held in high regard. There is no artifactual evidence at Cihuatán, however, that these or any other species of plant had been deified. We speculate that domesticated cotton and perhaps incipiently domesticated (that is, tended) indigo were grown, probably for commerce. Cacao for use as a beverage or involved in commerce is suggested from the flotation data.

Other species of plants which may have been tended or actively encouraged include trees bearing edible fruit or seed (e.g. huiscoyol palm, cashew, cacao).

Considerable care may have been given to volunteer individuals of such species if they happened to germinate near seeps, springs, or house terraces where carrying water or pot irrigation during the dry season was reasonably easy. Although not recovered from flotation, the moro tree (Crescentia alata) might have been encouraged for shade. Since it is a native of the area and is adapted to open habitats, it would not have required supplemental water.

Numerous weedy elements of the local flora were recovered in flotation— beggar's lice (Desmodium sp.), flora amarilla (Baltimora recta), mimosa, and escobilla (Sida sp.). Seeds of these plants may have been inadvertently brought into the dwelling during occupation.

The reaction to plants such as these may have been different for non-elite and elite classes. Except when beggar's lice fruit was being removed from clothing and was then an inconvenience, these plants were most likely ignored by people living in the non-elite sections. For people of the elite classes, however, such plant species were probably actively discouraged at least around their dwellings and in the ceremonial centers.

The morning glory seeds recovered in flotation may have several origins. They, along with other species typical of open, disturbed habitats, such as the weedy elements noted above, may represent modern background flora growing on the site and incorporated into deeper levels of soil through plowing, dry season earth cracks, rodent activity, and other action which results in mixing. (Insect parts could reach lower levels in the same manner.) Since more than one species, maybe even two genera , of morning glories is involved, a judgment concerning their use, if any, is unwise until identification to species is certain or until corroborative data is forthcoming. For example, some members of the Convolvulaceae (Morning Glory Family) are today used in El Salvador as a quelite or green, cooked vegetable. Also, it is known that other species in the genera Ipomoea and Rivea contain lysergic acid derivatives and were consumed as hallucinogens as closeby as Oaxaca, Mexico. Thus, until additional information is available, little can be said regarding the probable reaction of the people in the different segments of Cihuatan society to the morning glories recovered through flotation.

Trade

At the Puleston Conference mentioned earlier, Payson Sheets summarized the environmental and demographic consequences of the eruption of Volcan Ilopango, *circa* A.D. 260. Approximately 10,000 km^2 of land, mostly north and northwest of the volcano, were rendered uninhabitable because crops could not be grown on the very acid volcanic ash deposits. By approximately A.D. 600 (radiocarbon date) there is evidence of thorough human recolonization, apparently because sufficient weathering of the ash had occurred to permit agriculture. Sheets argued that during the period when most of El Salvador was unoccupied, previously existing trade routes had been rerouted. Thus the A.D. 600 settlement was a deliberate scheme to reestablish control of trade items, particularly production of obsidian and its transport north-and northeastward. Although Sheets did not mention Cihuatan, it may have been a part of this manipulative scheme since it is strategically located. Additional work is needed to establish the details of the position Cihuatan may have occupied on Postclassic trade routes between the south (Nicaragua and Costa Rica) and north (the Guatemalan and central Mexican highlands, and the Mayan lowlands). Regardless of all of this, however, several lines of evidence suggest that Cihuatan may have had a textile industry based on cotton and indigo, with maize being cultivated for local subsistence and possibly also for trade.

Microhabitats

Although the presence of many definable microhabitats in a tropical area means that there was potential for growing many different kinds of plants, we should stop short of saying this sort of thing actually occurred at Cihuatan.

In the modern situation, we were surprised at the apparent scarcity of household gardens and flower beds nearby and at the amount of market produce apparently brought from neighboring countries. If the option of depending on import exists now, it may also have existed in Postclassic times. It will be an exacting game to provide documentation for trade vs. local production in both subsistence and luxury item categories. For this reason, and because intrasite variability may be quite broad, we think a much larger flotation effort should be mounted in future field seasons supported by more intensive collection of living plant parts for better identification of the flotation materials that are recovered.

Vulcanism

It seems promising to pursue the volcanic history of the site. Late in the 1979 field season, Miksicek and Harlan had the opportunity to observe the stratigraphy of the west bank of the Acelhuate near Cerro San Dieguito. A large tree had been uprooted by wind and had torn away a section of the bank in its fall, thus exposing a face that would otherwise have been camouflaged by lianas, herbs, overhanging tree branches and various other growths. Many different layers of ash with intervening dark bands that might have contained charcoal showed in the approximately 25 vertical ft of deposit. Our awareness of the role that volcanic disruptions might have played during site occupation was greatly enhanced by this chance observation. And since we learned of Payson Sheets' discoveries beneath many feet of ashfall, we can't help wondering what kind of archaeology and botany lie many feet below our Postclassic excavations. Even in relatively recent times, ashfall may have produced changes in the pH of local soils and we would be most interested in soil analysis on a vertical profile for at least one field. It would be very nice to know how many times and with what specific effects, vulcanism had affected Cihuatan since the site was first occupied.

Phytogeography

A point of great concern to the botanists is whether opportunity to collect modern specimens during the dry season will materialize. In a land with a strongly biomodal precipitation system, the observer will see vegetation in one season that he did not imagine in the other. Study in the Salvadorean winter may well change both phytogeographical and ecological interpretations.

We have viewed the relict areas of tropical forest with great interest, and with some divergence of understanding. At present, our three viewpoints are rather like the blind men investigating an elephant. We need a much more thorough foray specifically into the Cerro de Colima, and the chance to do some vegetational survey in selected areas. A similar sampling, but for density and cover parameters, would be valuable for cutover forest lands exhibiting secondary tree growth. (Such an area is the so-called "bull pasture" between Cerro San Dieguito and the western ceremonial center.)

There is certainly enough information from the forest, however, to be sure that a large diversity of valuable resources existed under its eaves. There are other aspects, too. Living in the 1970's in Cihuatan, we are not as aware of the omnipresence of the forest as pre-industrial inhabitants would have been. We stand at the excavations and look out over open, rolling hills of relatively short vegetation with only a scattering of giant ceibas to remind us that our wide horizon is not what the ancients saw. They likely existed at the bottom of green, living walls, in openings handmade at considerable effort. Perhaps one of the advantages of an urban center located on a hill was the view which could be maintained by collective labor.

Irrigation

Was irrigation practiced at Cihuatan? Although opinions differ as to the necessity of pursuing this question, it is apparent that the cacao cash crop hypothesis, rendered inviable by the long Salvadorean dry season, would be instantly resurrected if evidence for irrigation were uncovered. It is therefore a question of importance. Tiled drains, apparently to remove water from plaza areas, were found in surveys by Bruhns, but by present information, active search for canal systems has not been carried out. One reason is that the entrenched modern Acelhuate does not lend itself to feeder canal development. However, during Postclassic times, it may have. If serious observations of the banks are done, manmade features of this and other kinds may show up amid the ash layers.

Climatic Change

Another idea receiving little attention during the 1979 season, but which may acquire more attention as information, and therefore questions, grows, is whether climatic change sufficient to affect the agrarian economy has occurred since Cihuatan began. Could the dry season be ameliorated by changes in the wind patterns along the narrow land strip of Central America? If this were true, and the length of the dry season were shortened, root crops could have grown without irrigation. Harris (1972:186) maintains that root crops such as yams and other climbers that have adapted to growth under a light tree canopy can tolerate dry seasons up to five months. The prospect for understanding changing climate through dendrochronology does not look promising at the moment. Tropical Central America trees tend not to exhibit crossdating. An attempt may be made in 1980 to test that assumption anyway. But another approach is through the changes which occur with climatic shifts in zoo-biota such as terrestrial molluscs. For this and other reasons, the project could use a field zoologist.

Botanical Team

Anyone interested in the botanical team concept would have certain questions about it at this point, the full field season and post-season report phase both being completed. The following are hypothetical queries and what we believe to be candid answers to them.

Did the team manage to get the necessary work done? Largely, yes. Our collections weren't as complete, or as neatly preserved, and our analyses not as thorough as ideal, but satisfaction was obtained.

Did the three botanists maintain communication well enough to keep each person informed whether in the field or at home? Not well enough. For the three personalities involved, more effort is required to really keep up a meaningful flow of letters and conversations.

Did the people feel comfortable with each other? Not consistently, and sometimes they were definitely uncomfortable. This appears to derive from not having cooperated previously on a joint effort, and thus not having learned to freely give where the other fellow(s) needs help and as freely accept assistance where oneself is weaker.

Did the botanical team interact well with the rest of the project members? For the most part yes, but the greatest benefits of team research are realized in the greatest development of this relationship, which is really just beginning at this moment.

Has the team produced integrated work? Only partially, as the reality of two, not one comprehensive, reports attests. But the potential exists for the future.

Do we really want to do it again? Yes and no. We would like to point out that we have all consented to be written into the 1980 work proposal. That's the yes part. On the other hand, the reality of who goes, when they go, and <u>if</u> they go resembles nothing so much as a movie serial with the protagonist perpetually in jeopardy. Therefore, "Tune in next week for the next exciting episode in our continuing adventure!"

Appendix: Plant Species of Cihuatan

The following species list is not definitive either for the Cihuatan area or for the 1979 field season. Approximately 70 species remain to be identified to genus and about 25% of those identified require further verification. We regard this as a working roster of local plants and hope to expand and further define it in subsequent study.

The listing includes at least one common name as well as the scientific name, family affiliation where known, and life form. There are probably some non-current scientific names. The authorities used are those listed in the References section of this report.

SPECIES	COMMON NAME	LIFE FORM	FAMILY
Acacia angustissima	guajillo	tree	Leguminoseae
Acacia hensei	Iscanal	tree	Leguminoseae
* Alocasia sp.	---	herb	---
Amaranthus sp.	---	herb	Amaranthaceae
Anemia hirsuta	helechito	fern	Schizoacaceae
Anona purpurea	cincuyo	tree	Anonaceae
** Asclepias enordatus	---	---	Asclepiadaceae
Baltimora recta	flor amarilla	herb	Compositae
Bambusa sp.	---	grass	Gramineae
Bauhinia diversifolia	pata de vaca	shrub-tree	Leguminoseae
* Begonia sp.	---	herb	Begoniaceae
Boerhavia erecta	golondrina iscorian	herb	Nyctaginaceae
Bougainvillaea glabra	---	vine	Nyctaginaceae
* Bursera simaruba	jiote	tree	Burseraceae

* Except for species starred (*), plants are in pressed or dried form housed at the University of Arizona, Tucson.

** When these names were given to us, they were spelled phonetically and have not yet been found.

SPECIES	COMMON NAME	LIFE FORM	FAMILY
Caesalpinia pulcherima	flor barbona	tree	Leguminosae
Caladium sp.	corazon	herb	Araceae
Calathea macrosepala	chufle	herb	Maranthaceae
Calycophyllum candidissium	solano	tree	Rubiaceae
Capsicum annuum var. conoides	chile picante	shrub	Solanaceae
Capsicum sp.	—	shrub	Solanaceae
Carica papaya	papayo	tree	Papayaceae
Cassia grandis	carao	tree	Leguminoseae
Cedrella mexicana	cedro	tree	Meliaceae
Ceiba pentandra	kapok, pachote	tree	Bombacaceae
Cenchrus sp.	—	grasslike	Gramineae
Cochlospermum vitifolium	tecomasuche	tree	Cochlospermaceae
Coffea arabica	—	tree	Rubiaceae
Commelina sp.	—	herb	Commelinaceae
Convolvulus sp.	—	vine	Convolvulaceae
Cordia alba	tihuilote	trees	Boraginaceae
Coriolus hirsutus	—	fungus	Polyporaceae
Coriolus sp.	—	fungus	Polyporaceae
Cornutia pyramidata	zapalote	vine/shrub	Verbenaceae
Crescentia alba	moro	tree	Bignoniaceae
Crotalaria	—	herb	Leguminosae
Croton hirtus	—	—	Euphorbiaceae
Curatella americana	chaparro	tree	Dilleniaceae
** Cyperus terminus	—	grasslike	Cyperaceae
Cyperus sp.	—	grasslike	Cyperaceae
Dendropanax	—	shrub/tree	Araliaceae
Desmodium	capitan de bejunco		Leguminosae
Discaria sp.	—	vine	—
Dorstania contrayerba	contra yerba	herb	Moraceae

SPECIES	COMMON NAME	LIFE FORM	FAMILY
Echinochloa colonia	—	grass	Gramineae
Elytraria imbricata	—	—	Acanthaceae
* Enterolobium cyclocarpum	guanacaste	tree	Leguminosae
Erythroxylon sp.	coca	shrub	Erythroxylaceae
Euphorbia glomerifolia	—	—	Euphorbiaceae
Euphorbia heterophylla	euforbio del monte	herb	Euphorbiaceae
Ganoderma lucidum	—	fungus	Ganodermataceae
Geaster sp.	—	fungus	Lycoperdaceae
Gesneria		—	Gesneriaceae
* Gliricidia sepium	madrecacao	tree	Leguminoseae
Gronovia scandens	pan oaliente	vine	Loasaceae
Guasuma ulmfolia	caulote	tree	Sterculiaceae
Hamelia patens	chichipinco	tree	Rubiaceae
* Heliconia latispatha	platanillo	herb	Musaceae
Heliotropium sp.	—	herb	Boraginaceae
Heliotropium ternatum	—	herb	Boraginaceae
Hyptis capitata	chibola	shrub	Verbenaceae
Indigofera suffruticosa	añil	shrub	Leguminoseae
Inga espuria	pepetillo	tree	Leguminosae
Iresine sp.	—	—	Amaranthaceae
Jatropha curcas	tempate	shrub	Euphorbiaceae
Kallstroemia maxima	verdolagita	herb	Zygophyllaceae
* Lantana sp.	cinco negritos	shrub	Verbenaceae
Lonchocarpus miniflorus	chapernonegro	tree	Leguminosae
Luehea candida	cabo de hacha	tree	Tiliaceae
Luehea speciosa	contamal	—	Tiliaceae
Lygonium polinorphum	crespillo	fern	Schizoaceae
Manihot sylvestris	—	herb	Euphorbiaceae
* Marantha armidinacea	—	herb	Maranthaceae

SPECIES	COMMON NAME	LIFE FORM	FAMILY
Ruta graveolens	ruda	herb	Rutaceae
Sapindus microcarpus	---	tree	Sapindaceae
Sclerocarpus divaricatus	colacate	herb	Sterculiaceae
Selaginella cuspidata	selaginela	prostrate herb	Selaginellaceae
Sida acuta	escobilla	herb	Malvaceae
Solanum bicolor	---	---	Solanceae
* Spondias	jocote	tree	Anacardiaceae
Stemmadenia sp.	---	---	Apocynaceae
Tabebuia pentaphylla	pink poui	---	Bignoniaceae
Tabernae montana donell-smithii	cojan	---	Apocynaceae
Trema micrantha	capulin montes	---	Ulmaceae
Tecoma stans	San Andres	---	Bignoniaceae
Tunera ulmifolia	damiana	shrub	Turneraceae

SPECIES	COMMON NAME	LIFE FORM	FAMILY
Martynia diandra	—	herb	Martyniaceae
Mascagnia ovatifolia	—	tree/shrub	Malpighiaceae
Melicocca bijuga	momon	tree	Sapindaceae
Melochia pyramididata	escobilla colorada	herb	Sterculiaceae
Mimosa pigia	sorza	vine	Leguminosae
Mimosa pudica	—	shrub	Leguminosae
Morus celtidifolia	—		Moraceae
Muntingia calabura	capulin	tree	Tiliaceae
Murraya paniculata	—	shrub	—
Passiflora coriacea	—	vine	Passifloraceae
Passiflora gossypiifolia	granadilla de culebra	vine	Passifloraceae
** Paullinia fausecens			
Pereskia autumnalis	matial	succulent	Cactaceae
Petastoma	bejuro de casa, pico de pato	vine	Bignoniaceae
Phellinis bodius	—	fungus	Hymenochaetaceae
Physalis sp.	—	herb	Solanaceae
* Pinus oocarpa	pino	tree	Pinaceae
Piper triquetrum	cordoncillo	shrub	Piperaceae
Piper tuberculatum	cordoncillo	shrub	Piperaceae
* Plumeria acuminata	frangipani	tree	Apocynaceae
Polonosia viscosa	tabaquillo	herb	Caprifoliaceae
Polygala sp.	—	—	Polygalaceae
Priva lappulaceae	mozote	herb	Verbenaceae
Ramaria sp.	—	fungus	Clavariaceae
Randia armata	torolio	shrub	Rubiaceae
Rauwolfolia tetraphylla	amatillo	shrub	Apocynaceae
Rhynchelytrum roseum	—	grass	Gramineae
Rivinia humilis	—	herb	Phytolaccaceae

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