THE TEOTIHUACAN VALLEY PROJECT

FINAL REPORT — VOLUME 1

The Natural Environment, Contemporary Occupation And 16th Century Population Of The Valley

by

WILLIAM T. SANDERS, ANTON KOVAR, THOMAS CHARLTON AND RICHARD A. DIEHL

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We dedicate the series of final reports of the project to Gordon R. Willey in acknowledgement of our debt to him for much of the methodological approach used in the project and to Pedro Armillas, who as teacher and colleague, was a major stimulus in the research design and theoretical orientation of the project.

The aerial photographs reproduced in this volume are based on a series produced by the Compania Mexicana de Aerofotos.

LIST OF PAPERS

Introduction . . . . . William T. Sanders

The Physical and Biological Environment of the Basin of Mexico . . . . . .Anton Kovar

The Geography of the Valley of Teotihuacan . . . . . William T. Sanders

Contemporary Settlement Patterns: An Overview . . . . . Richard A. Diehl

Contemporary Settlement Patterns: The Cerro Gordo, North Slope and Upper Valley Areas . . . . . .Thomas Charlton

Contemporary Agriculture of the Valley . . . . . .Thomas Charlton

The Population of the Teotihuacan Valley, The Basin of Mexico and the Central Mexican Symbiotic Region in the 16th Century . . . . . William T. Sanders

INTRODUCTION

by

William T. Sanders

BACKGROUND TO THE PROJECT

Specialists in Mesoamerican archaeology have long recognized the extraordinary role of the Basin of Mexico in Mesoamerican culture history. At the time of the Spanish conquest, it was the geopolitical heartland of the culture area, the center of a huge empire, the location of Mesoamerica's largest city and densest population. These characteristics were associated with an extraordinarily intensive system of agriculture, based on the construction of artificial islands, or chinampas, within the lakes; permanent irrigation, based on springs and glacial melt waters; and hillside terracing.

The characteristics of large polities and urban centers can be traced back in the history of human occupation of the Basin of Mexico through the preceding Classic Period and, at least incipient phases of such development, well within the Formative. There are indications that the basin was the center of empires or large kingdoms in Early Postclassic, Late Classic, and Early Classic times.

Stimulated by the publication of a paper entitled, "Notas Sobre los Sistemas de Cultivo en Mesoamerica," by Pedro Armillas in 1947, a theoretical school has evolved in Mesoamerican archaeology that conceptualizes such cultural processes as urbanism, centralized political power, and intensive agriculture as interrelated ones. Unfortunately, although much archaeological research has been carried out in the Basin of Mexico, it has been devoted essentially to chronological ordering and the study of art history.

In 1960 Eric Wolf received an NSF grant to support a conference entitled, "Coordinated Anthropological Research in the Valley of Mexico." The main purpose of the conference was to unite in a single discussion group a number of specialists in Mesoamerican studies with a specific interest in the Basin or Valley of Mexico. The conference had two primary missions: (a) to assess our present state of knowledge; and (b) to plan future research. The meeting took place in June, 1960, at the University of Chicago. The following persons were present at the conference: Robert Adams, Pedro Armillas, Pedro Carrasco, Michael Coe, Edward Deevey, William Mayer-Oakes, Rene Millon, Angel Palerm, Roman Pina Chan, William T. Sanders, and Eric Wolf.

The overall objective of the proposed program was to stimulate research leading to the definition of the role of the Basin of Mexico in the cultural development of Mesoamerica as a whole. In Wolf's original NSF conference grant, the following specific research objectives were listed:

1. Changes in the natural and manmade environment of the Basin of Mexico over time and the possible correlation of these changes with cultural factors.

2. The antiquity, development, and relative importance of major and minor patterns of land use over time.

3. The characteristics of settlement in the basin and changes in settlement patterns over time and related population problems.

4. The nature of the relationships between hamlets, villages, towns, cities, and similar units at various periods, including a discussion of relations between specific sites.

5. Problems of urbanization

6. The characteristics of symbiotic regions in the basin in various periods of time and their social consequences.

7. The relevance of environment to agriculture and settlement patterns to problems of social controls at various levels.

8. Patterns of ceremonial control at various time levels.

9. Patterns of political control at various time levels.

10. Patterns of warfare in the Prehispanic period.

11. Effects of the Spanish conquest and colonization on social and cultural groups in the Basin of Mexico.

12. Cultural persistence or change in major patterns throughout all known time periods within the basin.

13. Causal or functional relationships between various cultural patterns at different time levels.

On the basis of the discussion at this conference, it was decided at that time to implement an informal organization within which we would plan specific research and discuss the results of such research projects. Each of the constituent members would carry out specific research projects independently, but coordinated with overall objectives. One of these projects was to be directed by William T. Sanders and was called The Teotihuacan Valley Project.

The Teotihuacan Valley (a sub-area of the Basin of Mexico) was selected as a test study for several reasons. The great Classic city of Teotihuacan, perhaps the largest urban entity in Mesoamerican history and undoubtedly the earliest, was located there; and one of our major interests was the study of the process of urbanization. A series of previous studies of the Modern, Colonial, and Prehispanic occupation had been published and provided a base of data from which to work. Finally, Rene Millon planned a long-term study of the city, itself, thus supplementing our own research. His project is called the Teotihuacan Mapping Project and will be referred to as such in the remainder of this monograph.

The specific objectives of the Teotihuacan Valley Project are listed below:

1. To trace the history of development of agriculture in the valley, with special emphasis on irrigation and terracing.

2. To define and trace the history of rural and urban community types.

3. To construct, on the basis of data on settlements, at least a relative profile of population history.

4. Finally, and on a higher level of abstraction, to explore the functional relationships among such phenomena as settlement

patterns, agricultural techniques, and demography, and by an analysis of the interaction between these patterns to throw light on the urban development of the area.

The field work phase of the project was initiated in June, 1960, and completed in September, 1964. Financially, the project has been supported by The Pennsylvania State University, the Pan American Union, and, particularly, by the National Science Foundation. The research has been combined with a summer field school in archaeology for undergraduate and graduate students, with the most intensive activity occurring during that period. Nearly all of the excavations were conducted during the summers, with a field party varying from 5 to 20, including faculty and students. During the three years, 1961-1962-1963, several students and/or the field director have remained in the field on survey for additional periods, ranging from 3 to 9 months. Four graduate students have been with the project since its inception, and two participated in four of the five seasons, thus lending continuity to the project.

METHODOLOGY

Five basic methods were used in the gathering of data: archaeological excavation, archaeological survey, ethnographic studies, documentary research, and geographical survey (the latter including palynological analysis).

Archaeological Survey

This was the primary method, the other four may be considered as auxiliary. Survey methods were similar to those used by Willey (1953) in his Viru Valley study and involve a unit of comparable size. The Teotihuacan Valley has been photographed aerially twice at base scales of 1:10,000 and 1:25,000 by the Compania Mexicana de Aerofotos. Unlike the Viru Valley (at least without the use of more sophisticated photographing techniques) aerophotos have only limited utility in finding sites. They are extremely useful in mapping them, once discovered, and are also indispensible in studies of modern land use and settlement patterns. Larger mounds, such as pyramids, and features, such as dams, canals, and terraces, are visible on the photos; but residential structures are not. The torrential summer rains reduce such structures to heaps of rock and earth debris.

The first three years of the survey were devoted to what was termed general survey and consisted of locating sites approximately on the aerophotos and recording the chronological mode and range of occupation. Approximately 600 sites were located. Since 1964, continued and independent surveys by former members of the Teotihuacan Valley Project staff, Jeffrey Parsons and Thomas Charlton, have added an additional 100 sites to the sample. We estimate that our survey has probably located a minimum of two-thirds of all sites found in the valley.

Between June, 1963, and September, 1968, these sites were "intensively" surveyed. A detailed schedule was designed and data recorded for each site. Each schedule included: an aerophoto of the site area (amplified to 1:4000); a series of traced maps locating archaeological, natural and modern data; a description of the natural setting; modern occupation and land use of the site and surrounding area; archaeological features, including condition of the site, structures (with accompanying large scale drawings of walls, floors and profiles), estimates of sherd and other artifact distributions and densities; photographs of archaeological, natural, and ethnographic features; a sheet

for recording subjective impressions and interpretations; and laboratory sheets for analysis of surface collections.

Surface samples were collected from each site varying in number from one sample in very small sites to over 100 in large ones. An attempt was made to collect from very small areas (preferably a single structure). A minimum of 50 rims was collected for each sample, but the samples frequently ran into the hundreds.

The definition of a "site" is a highly arbitrary and subjective matter and an extremely difficult methodological problem, especially for the Aztec Period. In this report a site is defined simply as any localized area that shows signs of alteration by man as observable by archaeological method. This would include anything from an isolated house or ceremonial structure (a question here might be raised--how isolated?), dams, canals, terrace systems, to a city of 100,000 inhabitants. The important point is that a site is a "spatially isolatable unit". A spatially isolatable unit should have had some cultural significance to the prehistoric population and not be simply an archaeological abstraction if such units are to be used conveniently in settlement pattern analysis. One example will suffice here to illustrate the point. Classified as a single site would be a small area within which were a pyramid temple, a series of closely-spaced residential structures and a set of terraces and floodwater canals that were all "contemporary", that is, belong to one of the units of time used in the survey. Such a cluster of features is classified as a single site because it obviously formed a meaningful socio-economic-religious community in prehistoric times.

As a methodological procedure, sites were grouped into four major periods for recording. These periods were Formative, Teotihuacan (Miccaotli to Metepec), Toltec and Aztec. In actual analysis of the pottery a much more refined chronology is being used and is presented on page 8 . In cases of multiperiod sites (i.e., the four-fold divisions noted above) each period of occupation at the present stage of research is being considered as a site. When all samples are processed, each of the shorter phase occupations will be called sites.

One of the major problems of the survey has been that of sampling. At first the intention was to intensively survey all of the modern field units and houselots on the aerophotos for the entire valley. By this method the expectation was to locate and describe all of the sites.

At the end of the first field season the economic impossibility of the method became evident. On the basis of the geographic survey, the valley was then divided up into ecological divisions based on variations in slope, soil depth, and water resources, the prime determinants of settlement location and land use today. Sample areas of each of these types were surveyed using first, a more general extensive survey method and secondly,intensive field-by-field test strips over areas of several square kilometers each.

Archaeological Excavation

All excavations were conducted with two primary objectives in mind, to define the functions of the several types of structures encountered on survey and to refine or check the chronological sequence. Although much chronological

work has been done on the Basin of Mexico, surprisingly little of it has been adequately published and researchers have tended to be highly selective about presentation of data. For example, most of the literature dealing with Aztec and Toltec pottery has been concerned primarily with the decorated pottery, and for the Teotihuacan Period only gravelots have been reported in detail. Recently some studies of sherd material of the latter period have appeared (i.e., Tolstoy, 1958; Sejourne, 1959), but the former rested on a very inadequate sample of sites, the latter on poorly controlled stratigraphy. Only the Formative Period is adequately reported and then only for certain phases. For the Formative Period, reports are especially deficient on what we are calling Terminal Formative (i.e., the period between Vaillant's Late Ticoman and Miccaotli).

Althgether, excavations were conducted in 20 sites ranging from small test pits to large, multiroomed houses.

Documentary Research

Documentary research on general aspects of Aztec culture was initiated by Sanders as far back as 1949 and has continued intermittently since that date. Since 1963, Charlton has conducted an intensive survey of documents, specifically relating to the valley.

Ethnographic Research

In 1954, Sanders conducted a preliminary study of present-day settlement patterns, population distribution and agriculture. This data has been amplified in the present project and new data collected on house types, markets, village specialization, territorial organization and pottery uses and techniques of manufacture. The present population has continuity with the past (both cultural and biological) and the analysis of certain aspects of modern peasant life should be highly relevant to our research objectives.

Geographical Research

Gamio's study, published in 1922, involved considerable geographical research. The present project has amplified these data especially in the area of palynology. This palynological research was conducted by Anton Kovar, plant ecologist and palynologist at The Pennsylvania State University.

Problems

The Teotihuacan Valley offers certain advantages and problems to the type of research involved in the project. It is a denuded area, thus making mapping and observation using aerophotos a relatively easy task. Erosion and the use of the plow make surface sampling a useful method of dating, since in areas of thin soil the total range of occupation is readily visible. The area today is densely populated by peasant farmers with many cultural patterns linked to the past, providing the researcher with many insights into problems of archaeological interpretation and a convenient base line for studying problems of human adaptation to the area. Local peasants also serve as excellent guides in survey and excavation.

The area also offers serious problems, in some cases related to the same characteristics that aid research. Erosion presents one of the most difficult obstacles, especially with respect to one of our fundamental objectives, securing data on prehistoric irrigation and terracing. The archaeological and historical data suggest several periods of disastrous erosion, the most severe of which occurred in the sixteenth and seventeenth centuries following the Spanish Conquest. It is probable that many of the deeply cut barrancas that occur in the area were once shallow trenches capable of being dammed for floodwater irrigation (possibly even with a permanent or semi-permanent flow of water). Erosion of such streams has been lateral as well as vertical, so that any prehistoric stone or earth dams that may have existed would have been washed downstream. There are cases of stone dams only 50 years old now almost completely destroyed by water action.

The rate of erosion is extraordinarily rapid, a function of the torrential rainfall and generally sloping terrain. Erosion, of both gully and sheet type, is a common sight. As examples of the rapidity of gully erosion, several cases were noted of recently dug drainage ditches which generally have depths of only 50-60 cm. At the entrances of the ditches, however, where they enter the barrancas, water action has cut them down to the depth of the barrancas about 10-15 m. below. Such ditches are frequently only 40-50 years old! The force of water running over dam spillways built around 1900 has, in many cases, gouged deep pits into the bed of the barranca to depths of 20 m. Sheet erosion has in some cases denuded hundreds of hectares of gently sloping hillside since the Spanish Conquest.

Sheet erosion is very destructive to habitation sites which, in certain periods, tend to be concentrated on the lower flanks of the hills bordering the valley. It is doubtful whether any of the sites located in such terrain have escaped some erosion.

A corollary to the problem of erosion is that of deposition. The valley floor has a soil cover varying in depth from one to eight meters. Conceivably many sites, particularly small ones, could be completely buried by sediments derived from the erosion of nearby slopes. In the survey area literally hundreds of abandoned canal-ditch systems were noted, but sedimentation of such ditches is so rapid that it is impossible to tell whether they were abandoned 50, 100, 500 or 1000 years ago. The problem of deposition in the plain is a serious one (especially in the Lower valley and Delta where soil depth is greatest) since the survey data seems to suggest a definite preference for living sites on the piedmont and hilly flanks of the valley. The plain is the most productive segment of the valley for agriculture and the necessity of leaving such land for strictly agricultural use and using poorer lands for residence is probably the major factor at work. The presence of numerous sites buried by sediments in the plain would alter our ecological principle considerably or possibly invalidate it. The control offered by the modern settlement pattern and the fact that there are a few sites with good surface occupation in the plain (four are at least 2500 years old) would suggest that the apparent rarity of sites in the plain is not the product of a methodological error.

Along with these special problems, characteristic of the Teotihuacan Valley, is the general problem of dating and association. Multiphase and multiperiod

sites are common and frequently situated so close together or superimposed so that single spatial association dating of old canals, dams or terraces is a dangerous and deceptive process. The Aztec occupation above all is extraordinarily heavy, and very few earlier sites do not have an Aztec component as well.

A relatively refined chronological scale is being used for working out the history of settlement patterns. It is based on previous work published on the Basin of Mexico sequence, our own excavation and survey data and, for the Teotihuacan and Terminal Formative time spans, on new data from Millon's Mapping Project.

During the period from August-November, 1963, staff from the Teotihuacan Valley Project, from the Teotihuacan Mapping Project and from the Instituto Nacional de Antropologia e Historia, participated in a seminar on chronology and established a tentative sequence. The following chart also includes the published Basin of Mexico sequence.

	Teotihuacan Valley Sequence		Published Basin of Mexico Sequence	
	Periods	Phases	Periods	Phases
AD				
1500	Aztec	Teacalco	Aztec	IV-Tlatelolco
1400		Chimalpa		III-Tenochtitlan
1300		Zocango		II-Tenayuca
		Hueoxtoc??		I-Culhuacan
1200	Toltec	Atlatongo	Toltec	
1100		Mazapan		Mazapan
1000				
900		Xometla		Coyotlatelco
800		Oxtotipac		
700	Teoti-	Metepec	Teoti-	IV
600	huacan	Maquixco	huacan	III
500		Xolalpan		III
400		Late Tlamimilolpa		II-III
300		Early Tlamimilolpa		II-III
200		Miccaotli		II
100	Terminal	Apetlac (Early		II
0	Formative	Teopan Miccaotli)	Tzacualli	Teotihuacan
100	BC	Oxtotla		I
200	Late	Patlachique	Ticoman	Late
300	Formative	Tezoyuca		
400				
500		Cuanalan		
600				Early

	Teotihuacan Valley Sequence		Published Basin of Mexico Sequence	
	Periods	Phases	Periods	Phases
700	Middle	Chiconautla	Zacatenco	Middle
800	Formative	Altica		Early
900				
1000				
1100	??			??
1200				

At the seminar the pros and cons of using a number or name system and of using the terminology of the already established Basin of Mexico sequence was discussed. There was general agreement that a system of place names was a more convenient tool than one using numbers since the latter always creates problems as new, earlier, or intermediate phases are defined. It was also felt that the Basin of Mexico was much too large an area to be used as a unit of local chronology and that it was necessary, in terms of the research objectives of both the Teotihuacan Valley Project and the Teotihuacan Mapping Project, to have as tight a control of chronology as possible by eliminating space as a factor in stylistic variation. Further research on the Basin of Mexico, it is hoped, will validate this position. That the Teotihuacan Valley history diverges sufficiently from that of the rest of the Basin of Mexico to warrant separate phase names will be apparent throughout this study. Furthermore, it shall be demonstrated that using a sequential system this way will reveal much more data bearing on an understanding of the dynamic aspects of culture in the larger regions.

To a considerable degree the project was concerned with the problem of the history and evolution of social systems. In evaluating the social structure of any prehistoric people, the archaeologist can at best make only rough approximations since his data is primarily technological. The problem of reconstructing ancient social systems, then, revolves around the general question of the functional interrelationships between technology and society. Restating this point: What kinds of technology are most intimately related to what kinds of social organization? All human societies are organized on the basis of a few fundamental principles; rank, kinship, age, sex, territory and voluntary association are the primary ones. Two of these, rank and territory, have strong technological referents and our own analysis will concentrate on the kinds of social organization that are based primarily on these two principles. The growing interest of the archaeologist in settlement pattern analysis is based on the assumption that territorially based groups can be defined on the basis of spatial arrangements of residential units and civic buildings in an archaeological site or area. Keesing makes this point succinctly in the following passage:

> "Housing has a close functional relation to the habits of social aggregation of the group. An extended family household will require either a large structure, or else a cluster of related structures. More specific social arrangements may effect the layout of rooms, furnishings, sanitary facilities, and other elements in the physical setting....The layout of housing to form a community in a physical

> or structural sense also ties in with habits of social aggregation and helps to condition each generation in specific ways. Every group tends to have a visibly distinctive way of distributing living houses, together with public buildings, traffic ways, fences or walls and other community impedimenta."
>
> (Keesing, 1959, p. 207).

Variations in individual status may be reflected in housing, dress and burial, at least to the degree of demonstrating that variations in rank are characteristic or not characteristic of a society and the range of variation. Conceivably the factors responsible for producing differences in rank might be identifiable as well as the characteristics of social positions. Community rank variations should be definable on the basis of ranges in size and population, and in size and ornateness of civic buildings or residences.

At the present stage of archaeological method it seems improbable that kin-based social aggregations unrelated to territory (i.e., exogamous sibs, bilateral kindreds) are identifiable. Especially in this area of non-material culture we shall be constantly dealing with the question of probability levels of conclusions derivable from archaeological data. The general attitude of our study is optimistic; we intend to carry the possible and probable interpretations of the data to the limits of controlled and disciplined imagination. To clarify this point the following example is presented.

Data. As the result of excavation, a small, five-room structure constructed of stone and earth walls and earth floors was uncovered. Pottery, including cooking, storage and serving vessels and sherds; stone tools, broken and complete, including manos and metates, were abundant on the floors of the room and in the immediate vicinity of the outer walls of the structure. Manos, metates and pottery tended to be much more abundant in two rooms of the five-room structure. Furthermore, hearths were located in these same two rooms. A final fact, three of the rooms had interconnected doorways, the remaining two had an interconnecting door but there were no doors facilitating direct communication between the two room groups. The ceramics pertained to the Zocango Phase.

Conclusions--levels of probability:

Level one - the excavated structure was a residence. This is based on the overall plan, presence of hearths and the kind of occupational debris.

Level two - it was a two family house. One of the functions of the nuclear family is food consumption. All family groups have some mode of insuring privacy. The two apartment-like complexes, each with its own kitchen, would suggest a two family house.

Level three - the residential group was an extended family probably involving two nuclear families of unequal size. This conclusion is based upon the extraordinary frequency of extended families in non-urban societies around the world and the rarity of mutual residences of unrelated families.

That the two families were of unequal size is suggested by the range in number of rooms of the two apartments. This might also indicate that the two

heads of the nuclear families were not of equal rank, i.e., older-younger sibling or parent-child relationship.

Level four - the residential unit was possibly a patrilocal, extended family. This, of course, is going far out on the proverbial limb but documentary references to the Aztec emphasize the dominant role of the male in social, religious and political life. Today in Mexican villages residence is strongly patrilocal by barrio, community, and where extended families occur, by extended family.

Present plans are to publish the results of the project in a series of six monographs, comparable in size to this one. The subject matter will be divided as follows:

Volume 1	The Natural Environment, Contemporary Occupation and 16th Century Population of the Teotihuacan Valley.
Volume 2	The Formative Period Occupation of the Valley.
Volume 3	The Teotihuacan Period Occupation of the Valley.
Volume 4	The Toltec Period Occupation of the Valley.
Volume 5	The Aztec Period Occupation of the Valley.
Volume 6	Synthesis and Conclusions

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THE PHYSICAL AND BIOLOGICAL ENVIRONMENT OF THE BASIN OF MEXICO

Anton Kovar

TABLE OF CONTENTS

Physical Environment. 15
Meteorology 19
Vegetation. 21
Bibliography 25
Appendix A - Major Meteorological Events in the
History of the Basin of Mexico

List of Figures

Map 1 - The Basin of Mexico - Ecological Zones 59
Map 2 - The Basin of Mexico - Meteorological Stations 60-61
Table 1 - Summary of Meteorological Data 62
for the Various Stations in the Basin of Mexico
Table 2 - Summary of Meteorological Data for Chapingo (1941-1963) 63
Table 3 - Summary of Meteorological Data for Teotihuacan (1938-1963) 64
Table 4 - Annual precipitation in Tacubaya (1878-1950) 65
Pollen Diagram 1 - El Tular 66
Pollen Diagram 2 - Cuanalan 67

PHYSICAL ENVIRONMENT

The Basin of Mexico is located approximately between the meridians 98 32' and 99 15' long. west and the parallels 19 05' and 20 07' lat. north.

The area of the Valley is variously estimated. The map entitled "Plano General del Valle de Mexico" issued in 1959 by the Secretaria de Recursos Hidraulicos (Comision Hidrologica de la Cuenca del Valle de Mexico) gives the area as being 9600km^2. This includes, however, a considerable extension of land which does not drain into the Basin of Mexico but constitutes separate basins, such as those of Apam and Tecocomulco.

Tamayo (1962) in the 2nd edition of Geografia General de Mexico states that the area of the basin is 8153km^2. But in a table which appears on pages 294 and 295 of Vol. II of the same work it is shown that the sum total of the areas of the basins of the various streams found in the Basin of Mexico is 4652km^2.

For the purpose of this study, using the maps available, it is estimated that the actual area of the Basin of Mexico (sensu stricto) is about 7853km^2 of which 1330km^2 pertain to the Federal District, 4800km^2 to the state of Mexico, and 1723km^2 to the state of Hidalgo.

The Basin of Mexico is bordered to the north by the Sierra de Pachuca (3200m). The eastern limit is represented by the Sierra Nevada (Popocatepetl 5452m, Iztaccihuatl 5286m) and its northern prolongation, sometimes known as the Sierra de Rio Frio (Cerro Telapon 3500m, Cerro Tlaloc 3400m) which dips down to about 2450m just before meeting with the Sierra de Pachuca. To the south the Basin is bordered by Sierra de Ajusco (Cerro Cuautzin 3495m). The western flank consists of the Sierra de las Cruces which reaches an elevation of 3700m west of Mexico City but, like the Sierra Nevada, rapidly decreases in height northward to less than 2300m.

The four sierras listed convert the Basin of Mexico into a closed basin without a natural outlet. This fact has an important bearing on its ecology.

Orozco (1963) recognizes three zones in the Basin of Mexico based on elevation, namely La Zona Baja (Low Zone) all land below the 2250m contour line, La Zona de Lomerios (Hilly Zone) between 2250 and 2400m, and Zona Montanosa (Mountain Zone) between 2400m and the mountain peaks bordering the Basin. This is a very sound division which has important ecological and management implications.

The only improvement to this scheme, from the standpoint of what I am trying to accomplish in this paper, would be the subdivision of Orozco's mountain zone into two zones. One, which I would call the Intermediate Zone, extends between the 2400 and 2700m contour lines, and the other, the Mountain Zone proper, includes the land between the 2700m contour line and watershed of the Basin.

Orozco estimates the area of the Low Zone at 1507km^2. This zone was occupied in the past to a great extent by the beds of lakes, now nearly vanished. Because of the salinity of the ancient Texcoco Lake, the soils exposed upon its disappearance are unfit for cultivation. Furthermore, these soils, being of alluvial origin and containing large amounts of water, are susceptible to sinking, particularly under the pressure of heavy burdens. Today the bed of the old Texcoco Lake is 2237m above sea level but the level of the Zocalo, the civic square of Mexico City is 6m lower (Orozco opcit). Heavy extraction of underground water by means of deep wells and the draining of the Basin through the Tajo de Nochistongo and the tunnels of Tequixquiac have contributed greatly to the problems of the Basin in

general and of Mexico City in particular. Today the only regions that are agriculturally important in this zone are portions of Xochimilco and Chalco.

The Hilly Zone is actually a slightly inclined plain bordered by low hills. It occupies an area of approximately 2675km^2. Today this region is the most productive from the agricultural point of view and in part is under irrigation. Many towns and villages are also located in it. The upper reaches of this zone, particularly in the San Jacinto - Texcotzingo complex, east of Texcoco, are given to fruit production.

The Hilly Zone is followed upwards by the Intermediate Zone which begins at the 2400m contour and reaches to the 2700m contour. This is the "zona erosionada y arida" of Palerm and Wolf (1961). There is no doubt that this zone is eroded. Large areas along the western flanks of the Sierra Nevada and the Sierra de Rio Frio and the eastern flanks of the Sierra de Las Cruces above Mexico City have been made useless for any kind of cultivation through erosion. Only near the upper limit, along the foot of the high sierras, small settlements are present and small fields of wheat, maize, rye, and barley are cultivated, although wheat is preferred to maize because of its greater resistance to frosts. As will be seen later, this zone is anything but arid in terms of rainfall which is actually greater here than in the two lower zones. It is precisely because of the relatively higher rainfall that erosion is so rampant here. Since the ground has been stripped of its water retaining layer of soil, most of the precipitation descends as precipituous torrents into the basin floor below. I estimate that the area of this zone is about 267lkm^2.

The Mountain Zone, from 2700m and up, is mostly in forests, pine predominating. It occupies about 1000km^2. (Map I)

Scattered throughout the Low Zone are a number of elevations which break the monotony of the plain and are, like the rest of the Basin, of volcanic origin. Southeast of Mexico City is Cerro de la Estrella (2459m) which was the site of the Aztec New Fire Ceremony. Directly to the east of it is Cerro Santa Catarina (2700m). Still farther east are the twin peaks of Cerro Pino (2750m) and Cerro Tejolote (2700m). Southwest of Cerro Pino is Cerro Tlapacoya (2402m). To the northwest of Cerro Pino and projecting somewhat into what was the former Lake Texcoco is Cerro Chimalhuacan (2500m). Within the confines of the old Texcoco Lake are two isolated elevations, namely Penon del Marquez (2350m) and Penon de los Banos (2303m) famous for its thermal waters.

Directly north of Mexico City is the Sierra de Guadalupe consisting of several peaks, the highest being Cerro Tontepec (over 2900m). The Sierra de Guadalupe is actually an eastern arm of Sierra de las Cruces. Almost opposite, across the Basin is the Sierra de Patlachique, also consisting of several peaks, the highest being Cerro Patlachique (2800m). This sierra is a western extension of the Sierra de Rio Frio. Partly attached to the Sierra de Patlachique is the low and twin peaked Cerro Tezoyuca (2350m).

Cerro Chiconautla (2630m) rises directly north of Lake Texcoco and is about equidistant from both the Sierra de Guadalupe and the Sierra de Patlachique. On its southeastern flank a small adventitious cone, known as Cerro Tlahuico, is to be found.

To the north of the archeological zone of Teotihuacan is the Cerro Gordo complex. Scattered around the main peak, which reaches an elevation of 3050m, are several lower hills representing, in all probability, old adventitious cones. According to old reports the old name for Cerro Gordo was Tenan. In still other documents the name Temiztepetl is given. Tenan means stone mother; Temiztepetl means the mother of stone lion.

Cerro Gordo to the north, the Sierra de Rio Frio to the east, the Sierra de Patlachique to the south and Cerro Chiconautla to the west delimit the Valley of Teotihuacan, a subunit of the Basin of Mexico with a surface area of 600km^2.

The Basin of Mexico is dissected by several "rios" (rivers) or rather streams and innumerable barrancas. With very few exceptions, these carry water only during the rainy season and even then intermittently after heavy downpours. The exceptions consist of those streams which drain springs, such as the Rio San Juan or the complex or small streams that drain the western slopes of Sierra de Rio Frio. In the southeastern corner of the Basin perennial streams are also present that drain Iztaccihuatl and Popocatepetl. It is probable that some of the barrancas (ravines) which are now dry except during rainy season, may have carried water continuously. This would appear to have been the case for the section of the Rio San Juan located upstream from the springs.

Many springs emanate in the Basin of Mexico. The larger ones have played in the past, and still do so today, an important role in agriculture. Among them should be mentioned the springs which feed Lake Xochimilco, those which issue at about the 2700m contour line on the western flank of Sierra de Rio Frio and which provide irrigation water for the Texcoco plain, and last, but not least, the springs of San Juan Teotihuacan which, since Classic times have played a very important role in the development of agriculture in the Teotihuacan Valley.

Tamayo (op cit), citing data provided by the Secretaria de Recursos Hidraulicos, gives 6.79 million cubic meters as the mean annual flow for the Teotihuacan Valley measured at its southern outlet, at Tepexpan. Of this the springs of San Juan Teotihuacan provide only a very small part. It would seem that the outflow of these springs has decreased very radically during this century.

Before bringing up the subject of lakes in the Basin of Mexico it is advisable to give an outline of the geological events which brought them about.

During Early Tertiary times, the future Basin of Mexico was only a few hundreds of meters above sea level. Due to intense volcanic activity volcanic materials began to accumulate in such quantities and so rapidly that the erosive action was unable to carry them away. Thus they accumulated reaching a thickness of about 1000m under the present basin. They overlie folded marine sediments of the Mesozoic.

During the Middle Tertiary continued volcanic activity gave origin to the Sierra de Pachuca and, a little later, both the Sierra de las Cruces and the Sierra de Rio Frio were formed. The valley formed by these ranges drained southward by means of two rivers, one of which flowed in the direction of Cuernavaca and the other toward Chiautla. A slow sinking of the bottom of this valley took place, especially in the southern part, thus increasing the southward tilt of the valley. As a result of this sinking and the consequent change of level between the bottom of the valley and the western and eastern ranges bordering it, extensive alluvial fans, now known as the Tarango Formation, accumulated along the western and eastern flanks of the valley. It should be noted here that the zone called Intermediate in this paper coincides with this formation.

During the Early Pleistocene renewed volcanic activity gave origin to the Sierra de Ajusco, thus sealing off the valley and transforming it into a basin. At about the same time, arose the volcanic cone of Iztaccihuatl and, a little later that of Popocatepetl, not the one we know today, but its predecessor, now called Ventorillo. The present day Popocatepetl had its origin during late Post-glacial or Recent.

The sealing off of the Basin occurred at a time when glaciers of some extent covered at least some of the elevations bordering the basin. White (1962) has shown that on the western flank of Iztaccihuatl glaciers descended at one time down to the 2950-3050m contour line. Today the small glaciers reach, at most, the 4300m contour, and occupy areas very small in extent. For glaciers to reach all the way down to the 3000 contour line and to occupy an area as large as is indicated by the terminal moraine, the climate must have been quite cooler than it is now, but above all, precipitation must have been considerably greater than it is today. At present snowcaps, both on Iztaccihuatl and Popocatepetl are much more pronounced during the rainy (and warmer) season than they are in winter - which in the Basin of Mexico is dry.

The melting of glaciers accompanied by possibly higher precipitation and repeated volcanic activity were responsible for the rapid filling of the Basin with quaternary sediments. The depth of these reaches 400m under Mexico City and 800m under Xochimilco. These depths seem to confirm the pre-Pleistocene southward slant of the basin.

The geological account as given above is based on Mooser (1963). Others, while not disputing the southern drainage of the Basin, maintain that at one time there must have been some kind of connection with the Lerma River basin as studies of fresh water fishes appear to indicate.

As the melt waters and the precipitation waters began to accumulate within the Basin a large lake was formed. The true extent of this lake is difficult to ascertain as there is considerable discussion about the ancient shore lines. It is very probable that the old shore line coincided fairly closely with the 2250m contour line. As precipitation decreased and the rate of evaporation began to increase with the slowly rising temperatures, the level of the lake began to descend and eventually several separate lakes could be recognized, namely Lakes Chalco and Xochimilco in the southern end, Lake Texcoco in the central part, and Lakes San Cristobal, Xaltocan and Zumpango in the northern part of the valley.

Lake Texcoco having the lowest level received not only the waters originating in its own drainage area but, at times, the excess waters of the other lakes would also spill into it. As a result, the waters of Lake Texcoco became progressively more saline, since the only way water could leave it was through evaporation. Incidentally, sometimes, given the localized nature of rainfall in the Basin, the level of Lake Texcoco would rise to a greater height than that of Lake Xochimilco and the saline Lake Texcoco waters would flow into Xochimilco. The Aztecs soon learned how to cope with this situation by constructing a system of levees which permitted the flow of water from Xochimilco into Texcoco but prevented the reverse flow.

Today these lakes have practically disappeared. The only remains are a very reduced and rather swampy Lake Zumpango, a small and seasonal body of water where once Lake Texcoco extended, and Xochimilco reduced to canals between chinampas. Lakes Chalco, San Cristobal, and Xaltocan are non-existent.

METEOROLOGY

Although the Basin lies within the geographical tropics, its climate is far from tropical. This is due primarily to its elevation above sea level.

General data for 21 stations within the Basin are given in Table 1. It should be noted that some of the stations cited gather precipitation data only. The sources of data given in Table 1 are Atlas Climatologico de Mexico, Servicio Meteorologico Mexicano, published in 1939 and Climatologia de Mexico by Vivo and Gomez, published by the Instituto Panamericano de Geografia e Historia in 1949. Although it is claimed in the latter publication that it presents new data, the average monthly and annual data given are the same as those in the 1939 atlas. Only for three stations, namely Tacubaya, Chapingo, and Teotihuacan has it been possible to assemble monthly rainfall and temperature data as well as extreme monthly maximum and minimum temperatures. For Teotihuacan and Chapingo, and in part Mexico City, evaporation data have also been obtained.

The period covered by these data extends from 1878 to 1950 for Tacubaya. The data for Chapingo begin with January 1941, those for Teotihuacan with January, 1938, and both end with April, 1963. It should be noted here that the records for the three stations, for which more complete data were obtained, are by no means complete. There are periods, sometimes of several months during which no data were recorded. The most deficient are the evaporation data.

The Comision Hidrologica de la Cuenca de Mexico calculates, for purposes of water resources management, that the average annual rainfall in the Basin of Mexico is 700mm. Actually, the average annual rainfall varies from 1363.8mm in Amecameca to 418.7mm at Pachuca. There are also rather considerable variations from year to year at the various stations. Thus at Teotihuacan a maximum of 791.5mm (1958) and a minimum of 378.7mm (1960) have been recorded. For Chapingo we have a maximum of 764.5mm and a minimum of 381.7mm. Tacubaya had a maximum of 894.6mm (1878) and a minimum of 331mm (1894).

In general, it can be said that annual rainfall increases from north to south. Thus Pachuca in the extreme north of the Basin has an average annual of 418.7mm. Chapingo near the center of the Basin has 581.7mm and Xochimilco at the southern end has 739.8mm. The average annual rainfall appears to increase also with elevation. While Chapingo at 2250m has, as stated 581.7mm, San Juan Guadalupe at 2494m has 1015mm, San Rafael at 2530m has 1197.6mm, and Desierto de los Leones at 3220m has 1281.4mm. Hueyatlaco, however, at 3557m has only 1155mm. It would seem then that once the 3300m contour line is reached, the average annual rainfall decreases. That rainfall decreases above 3300m is also shown by the extremely tenuous snow caps on Iztaccihuatl and Popocatepetl.

Tables 2 and 3 give a summary of the more detailed meteorological data obtained for Chapingo and Teotihuacan. They show that the Basin of Mexico is characterized by a rainy season of 5 months beginning in May and ending in September. The other months may be considered dry, although both April and October still may have significant amounts of precipitation. The rainy months account for 75% of the total precipitation. The early start (April) of the rainy season is crucial for the planting of corn. If rains do not start on time or, if after a good start, they slacken in May or June, the crop may be lost if irrigation is not available. Moreover, a late planting exposes corn to early frosts in September.

Apart from the worry about the start of the rainy season, the greatest problem faced by the agriculturist is the extreme variability of rainfall from year to year.

During the rainy season the rains usually take the form of heavy downpours of the convectional type. They generally start in the middle of the afternoon and end in the evening. Days of continuous, chilly drizzle occur but they are not very common. The heavy downpours often cause flash floods, sometimes miles from the area where rain fell.

Tables 2 and 3 also show that February tends to be the driest month of the year and that the dry months, on the average, tend to be the most irregular as regards rainfall. January, February, and December have shown no appreciable rainfall during about half of the period of years for which data are available.

The rainy months seem somewhat more regular but, even here, about half of the months show below average precipitation. As shown in the tables the differences between maximum and minimum monthly rainfall are rather great.

Temperature variations are also striking in the Basin. The average annual temperature at Teotihuacan for the period under consideration is 14.4°C. The extreme maximum temperature recorded was 34.0°C and the extreme minima was -8.3°C. At Chapingo the average annual temperature is 14.9°C, the extreme maxima 34.5°C and the extreme minima -11.5°C. The average temperature for Tacubaya is 15.4°C, the extreme maxima 33.8°C and the extreme minima -4.2°C. The coldest month tends to be January and the warmest, May. The increasing cloud cover tends to reduce the temperatures during the rainy season.

Tables 2 and 3 also show that at Chapingo and Teotihuacan frosts are very common in January, February, November and December. They may occur as late as May at Chapingo and April at Teotihuacan.

As data in Table 1 indicate the floor of the Basin of Mexico has more extreme temperatures than stations located at some elevation above the plain. Hueyatlaco at 3557m above sea level shows an extreme maximum temperature of 20°2°C and an extreme minima of only -5.0C. This would make the extreme temperature range 25.2C. On the other hand, the extreme temperature ranges for Chapingo and Teotihuacan are 46.0 C and 46.3C respectively.

As already mentioned, evaporation data are very incomplete. They are available only for Chapingo and Teotihuacan with a few additional data for Tacubaya and Pachuca. It is evident that evaporation is between three to four times as high as precipitation. Naturally evapotranspiration would be still higher. This fact has a very important bearing on plant life in the Basin and on its lakes.

To project the present data into the past information about meteorological phenomena has been assembled covering the Postcolonial, Colonial and Precolonial periods. The compilation is by no means complete but it gives some important clues of past meteorological conditions. The compilation will be found in Appendix A.

VEGETATION

The general impression which one receives, upon arriving in the Basin of Mexico, particularly during the dry season, is that it appears more arid than would be expected on the basis of meteorological data alone.

Much of the original vegetation has been destroyed, especially in the lower elevations. After the Conquest Spaniards needed timber for construction. Many trees were cut to make charcoal, the need for which has decreased only relatively recently with the introduction of gas and electricity, since poorer households still use charcoal. The introduction from Europe of grazing and browsing animals has further depleted the natural vegetation giving advantage to nonpalatable plants, particularly cacti, other succulents and certain spiny leguminous shrubs.

The progressive draining of the Basin has also deeply affected plant communities, particularly those in the vicinity of the beds of the ancient lakes.

It should not be forgotten, however, that even long before the Conquest there must have occurred profound changes in the natural vegetation. The dense population of the Classic and post-Classic periods must have had a considerable effect on the natural environment. That there must have been some concern regarding the destruction of vegetation is indicated by the laws promulgated under Netzahualcoyotl establishing severe punishments for those who cut trees.

Since the Conquest some exotic species have been introduced. Apart from cultivated crops such as wheat, oats, barley, rye, alfalfa, several edible legumes, and fruit trees, some trees and many weeds have also become well established. The most common among these is pirul (Schinus molle), originally from Peru, which has become ubiquitous throughout Mexican uplands. Near Mexico City slopes have been planted with eucalyptus (probably Eucalyptus globulus). This Australian tree, of rapid growth, is also planted along highways and several large trees may be found around the ruined hacienda "El Molino" near Texcoco. A species of Casuarina, another tree native from the southern Pacific, is commonly planted in parks and along trees. The date palm (Phoenix dactylifera) lines many of the streets in Mexico City. The calla lily (Zantedeschia aethiopica), a native of Africa, grows along canals in Xochimilco and San Juan Teotihuacan; its flower is sold in the markets. Water hyacinth (Eichhornia crassipes), originally from South America but now world-wide in distribution and water lettuce (Pistia stratiotes) a native of the tropical American lowlands, are particularly abundant in the canals of Xochimilco.

In general, it can be said that only faint traces of the original vegetation remain, especially below the 2700m contour line, that is within the area where crops are cultivated. Only above this line are there forests, consisting chiefly of pine (Pinus hartwegii). According to Beaman (1962) the timberline on the western slopes of Iztaccihuatl is at 4000m and on the northwestern slopes of Popocatepetl at 3900m. In both cases the timberline tree is P. hartwegii. The only other conifer at or above the timberline is a juniper (Juniperus monticola). Beaman further states that the lower limits for P. hartwegii on these slopes are at 3100-3200m.

However, Rzedowski (1954), in his study of the vegetation of the Pedregal, located south of Mexico City on the lava fields which cover Cuicuilco and Copilco, notes the presence of this pine at elevations as low as 2900m or perhaps even lower.

Rzedowski's study is of particular interest because it deals with an area which has been perhaps the least disturbed until relatively recent times. This area, covered with lava flows which issued from Xitle, is unsuitable for agriculture and being rather rugged, was for a long time left almost intact. Only in modern times it has been invaded in part by construction, first of the National University and more recently of residential housing. Rzedowski's paper also shows that various species of oaks may be found as low as 2500m, as they are found today at the Pedregal and on the lower slopes of Cerro Texcotzingo and elsewhere.

Much of the Basin below the 2500m contour line is covered with grasses and various forbs which are closely cropped by grazing and browsing animals. In the area formerly occupied by Lake Texcoco, where the soils have a high saline content, three species of grasses are very common, namely Sporobolus plumbens, Distichlis prostrata, and D. spicata.

The vegetation of Cerro Gordo, north of the archeological zone of Teotihuacan, like the rest of the Basin of Mexico, has been deeply affected by man. The southern slope, from the summit down to the valley level is completely devoid of trees. The upper reaches are covered by heavily broused scrub oak about three or four feet high. On the lower slopes are found various shrubby plants among which Compositae seem to predominate.

The northern slope appears much more eroded in its lower reaches than the southern slope and several deep ravines are present. However, near the very summit, a forested area is still present. It consists mainly of good-sized oaks, a cypress (Cupressus Lidleyi) and a species of madrono (Arbutus xalapensis) characterized by its reddish shiny bark.

One native informant, who was very obviously a resident of Maquixco Alto, situated at the foot of the northern slope, related that the inhabitants of San Francisco de las Piramides, located south of Cerro Gordo, cut down the forest on their slope for the purpose of making charcoal, then tried to encroach on the forest on the opposite side and belonging to Maquixco Alto and had been stopped by force, that is guns. I am relating this to show that some of the destruction of woodlands must have taken place relatively recently, probably after 1917 when, after the land reform, the large haciendas were broken up and became part of the ejidos of the various villages. This may have been an unintended result of the land reform.

It is rather difficult to reconstruct the original plant communities of the Basin. In general, it can be assumed that land above the 2700 contour line was occupied by forests made up mostly of pine with the inclusion of cypress (Cupressus Lidleyi) and various species of oaks, especially at the lower limits of the pine forest. It is interesting to note that 21 samples of charcoal that were excavated during the reconstruction of the archeological zone of Teotihuacan, were of coniferous (pine) wood. It is as if Teotihuacanos used predominantly, if not exclusively, pine in their constructions.

Oaks were apparently the most important ingredient of vegetation in the area delimited by the 2500m and 2700m contour lines (my Intermediate Zone). Some oaks may have reached even somewhat lower on certain slopes, as is the case still today on Cerro Texcotzingo. It would seem that some of this land, particularly that between the Cerro San Jacinto complex and the foothills of Sierra de Rio Frio, east of Texcoco, was more densely populated and, perhaps, more cultivated, in pre-Conquest times. Today it is very badly eroded and practically uninhabited.

It is evident from Bernal Diaz' description that the shallow waters of Lake Texcoco were overgrown with reeds. So were the many swampy places within the Basin. The streams, many of which were permanent, were bordered by swamp cypress (Taxodium mexicanum). This magnificient tree was in the past much more widespread. The Parque del Contador, a short distance northwest of the city of Texcoco, was a favorite recreation spot of Netzahualcoyotl; it is still a favorite weekend place for many Mexicans.

The pollen diagrams of cores obtained in the Valley of Teotihuacan confirm, to a certain point, the picture given above. Two of the pollen diagrams are given here in condensed form and will be published in detail elsewhere. Diagram 1 is from El Tular, a swampy area located about 3km southwest of the springs of San Juan Teotihuacan. Tular in Spanish means place where reeds grow. In 1964, when the samples were taken, there were no reeds present and the swampy area was only about an acre in extent. Local residents gave the information that in the past the swamp was much larger in size and that its size was gradually reduced through drainage ditches.

The pollen diagram shows a gradual but steady decrease in pine pollen from the bottom toward the top. For each level 1000 to 1500 pollen were counted to insure a good representation of pollen other than that of pine. One surprising observation was made during the pollen count and it was that reed (Typha) pollen was absent as was that of swamp cypress (Taxodium). Although the area is surrounded today, as it was undoubtedly in the past, by fields of maize, maize pollen, although present, represents such small numbers that only its presence was recorded but not its percentage. The gradual decrease in pine may be explained by the gradual destruction of pine forests. As the forests retreated up the slopes, farther away from El Tular, less pollen reached the place of deposition. Oak pollen, although it shows increases and decreases, and a definite decrease toward the top, follows an entirely different pattern. Rather surprising was the presence of isolated basswood (Tilia) pollen grains at various levels of the profile. Basswood is not known to exist at present in the Valley of Mexico; a species of basswood, (Tilia longpipes) grows in Sierra Madre Oriental.

The pollen diagram 2 is that of a core taken near Cuanalan at the site of an excavation of a Cuanalan phase dwelling. It seems to agree considerably with the pollen diagram from El Tular except that it appears to be truncated at the top, and reed (Typha) pollen is present toward the bottom of the profile.

Sears (1952) and Sears et.al. (1955)have discussed pollen diagrams obtained by him from cores obtained under Mexico City. From them he draws important conclusions as regards climatic changes in the Basin of Mexico. According to him there was a succession of alternating humid and dry periods in the Basin. I must confess that the pollen profiles given in the present paper do not confirm Sears' conclusions and that they rather seem to bear out the findings of Bopp-Oeste.

Much has been written and theorized about the rising and falling levels of lakes in the Basin of Mexico. It was automatically assumed that if the lake level rose, it meant increased precipitation.

The picture that emerges from the consideration of the data in this paper is the following. The closing off of the southern outlets of the Basin by the formation of the Sierra de Ajusco and the somewhat later melting of the glaciers on Iztaccihuatl and Popocatepetl together with high precipitation were responsible for the formation of the lake(s). After this initial accumulation of waters in the bottom of the Basin, precipitation decreased considerably. As the average temperatures rose, evaporation from the lakes eventually became greater than precipitation. Thus the lake level began to descend. However, erosion materials began to fill the lake beds. Thus, even without an increase in annual rainfall, the lake level would rise simply because of the shallower lake bed. On the flat bottom of the Basin, even a small rise in lake level tends to occupy a considerable area along the shores. Moreover, as population density rose in the Basin and as more and more of the forest vegetation was destroyed, water that had been used up in transpiration, was added to the lakes. It is a well known fact, that the destruction of forest cover can, under certain conditions, raise the water table to such a degree that the area, previously under forest, may become swampy. Perhaps the floods which plagued Tenochtitlan and its successor, Mexico City in late Aztec and Colonial times may be explained in this way.

Another thought comes to fore regarding the lake or lakes in the Basin. The presence of bodies of water must have had a mitigating effect on the climate. As has already been indicated frosts may occur at Chapingo as late as May or as early as September. It is probable that the presence of lakes delayed at least the the early fall frosts if it did not prevent late spring frosts. This would have made agriculture, particularly maize cultivation, somewhat less precarious than it is today.

The Basin of Mexico has a unique ecological setting. It represented certain challenges to its pre-Conquest settlers which they answered by adapting themselves to the environment and, even more, by turning it to their advantage. Even today, where the inhabitants cling to the old Indian ways, the Basin still shows some of its old splendor. It is a sad comment on the western man and his civilization what has been done to the Basin since the Conquest and particularly in this century.

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APPENDIX A - MAJOR METEOROLOGICAL EVENTS IN THE HISTORY OF THE BASIN OF MEXICO

The sources for this compilation are the following:

1. Various codices and the writings of Ixtlilxochitl.

2. Lorenzo, J. L.: Climatic alterations in the Basin of Mexico during the XVIth century.
Given at: Conference on the climate of the XIth and XVIth centuries. Aspen, Colorado. June 16-24. No year.

3. Noble, Gontran and Manuel Lebrija 1957: La Sequia en Mexico y su prediccion. Boletin de la Sociedad Mexicana de Geografia y Estadistica. Vol.

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1287 - 1296 3 Reed - 12 Flint	And this Chalchihuitzin was the one who climbed Popocatepetl to propitiate rain because at that time the sun and drought were strong and there was hunger and need.. Relations of Chalco Amaquemecan- Fifth Relation
1324 1 Flint	This was the time when the inhabitants of Chalco..ate plants of acxoyatl in the margins of the lake. Relations de Chalco Amaquemecan - Sixth Relation
1332 9 Flint	Then began the years during which it did not rain.. Relations of Chalco Amaquemecan - Fifth Relation
1333 10 House	It was then that it did not rain in any part of Chalco during this year.... Relations of Chalco Amaquemecan - Third Relation
	It was two years that it did not rain Relations of Chalco Amaquemecan - Fifth Relation
1335 12 House	It was the fourth year that it did not rain in the country of the Chalcas; however, in the plantings of the Tlacochcalcas the rain fell though their fields were located in the middle of the plantings of the Chalcas. Relations of Chalco Amaquemecan - Seventh Relation
1347 11 Reed	Again the Tlacochcalcas Chalcas saw Popocatepetl smoking. It was a long time since it was seen smoking. Relations of Chalco Amaquemecan - Seventh Relation
1347 9 Reed (?)	For the first time the mountain now called Popocateptl was seen to smoke....It was 12 years that Tlazolyaotl /"fraternal war" (fictitious war)/ was held but it was ended after the four years of drought, four years during which not a drop fell. Relations of Chalco Amaquemecan - Sixth Relation
1356	Thirty-One years after the foundation of the city (of Mexico) fire emerged from the volcano (Popocatepetl?) Historia de los Mexicanos por sus pinturas
1382 7 Rabbit	We had a flood. Many chinampas were devastated by the water of the rains. Anales de Tlatelolco - Codice de Tlatelolco
1383 8 Reed	...There was hunger and Mexicans ate Acpatlaotli (?) ate cocolli (water snails), atetetzo (water sponges,... Anales de Tlatelolco - Codice de Tlatelolco
1385 10 House	....Water retreated and the chinampas were left stranded on land. Anales de Tlatelolco - Codice de Tlatelolco

1446
6 Rabbit

This was really the year in which a plague of locusts appeared that devoured all food, leaving hunger and need.
Anales de Tlatelolco - Codice de Tlatelolco

This year a plague of locusts appeared which devoured everything; for this reason there was hunger because they (the locusts) ate all the maize.
Relations of Chalco Amaquemecan - Seventh Relation

1447
7 Reed

There was so much snow that many people died...
Codex Telleriano-Remensis

1449
9 House

Also in this year so much snow fell that it covered everything
Relations of Chalco Amaquemecan - Seventh Relation

1450
10 Rabbit

...the snow that fell over the entire land was so high that it reached in most parts a stadium and a half, which caused the destruction and collapse of many houses as well the destruction of all trees and plants and the country was so cold that many people died and especially older people; and during the three following years all plantings and products of the earth were lost so that most people died.
Ixtlilxochitl

....there was hunger. All kinds of aquatic animals were found dead on the surface of water: fish, frogs, axolotl, etc...
Anales de Tlatelolco and Codice de Tlatelolco

This year there were heavy frosts which froze everything. There was hunger and need. Thus began the five years during which there was nothing to eat.
Relations of Chalco Amequemecan - Third Relation

In this year there was again a heavy frost which caused hunger for five years and which did not leave anything to eat during the entire year.
Relations of Chalco Amaquemecan - Seventh Relation

1451
11 Reed

Crops lost
Ixtlilxochitl

In this year knee deep snow fell; it fell during five days
Codice Chimalpopoca - Anales de Cuauhtitlan

.... a deep freeze fell which froze maize when it was germinating.
Anales de Tlatelolco - Codice de Tlatelolco

...Third year of hunger. All the way to Chalco came the ferocious beasts and buzzards and birds of prey, the same as to all other villages. Everywhere, in the forests

and grasslands died even young men and women. Their flesh was so wrinkled and dry as if they were old persons. Hunger was very great.
Relations of Chalco Amaquemecan - Seventh Relation

1452
12 Flint

Crops fail again.
IXtlilxochitl

Another frost came and maize froze at the very moment of germination.
Anales de Tlatelolco - Codice de Tlatelolco

Second year of hunger, need, and suffering for lack of food in Chalco. The buzzards were searching everywhere for corpses to eat in the hills, lowlands, and forests. The young men and women looked like old people because their flesh was so full of folds and wrinkles. The boys and girls became so because of great hunger.
Relations of Chalco Amaquemecan - Third Relation

The hunger continued
Relations of Chalco Amaquemecan - Seventh Relation

1453
13 House

Crops fail once more.
Ixtlilxochitl

...another frost fell during the Tecuilhuitl (the feast of the Lords. June 12-July 1). Then the ears (of maize) froze. In this year there was also an earthquake and fissures appeared in the ground and chinampas collapsed; and people were selling themselves to others because of hunger.
Anales de Tlatelolco - Codice de Tlatelolco

In the year 128 (after the foundation of Tenochtitlan hail fell in Mexico to such a degree that houses collapsed and the lake froze over.
Historia de los Mexicanos por sus pinturas

This was already the fourth year during which there was nothing to eat.....
Relations of Chalco Amaquemecan - Third Relation

There was still nothing to eat. The deadly hunger continued.
Relations of Chalco Amaquemecan - Seventh Relation

1454
1 Rabbit

At the beginning there was a very large eclipse of the sun, and then illness grew and so many people were dying that it appeared as if nobody was going to survive, such was the calamity that afflicted this land and hunger was so great that many sold their children in exchange for maize in the province of Totonicapan where no such calamity occurred.
Ixtlilxochitl

There was such a famine that many people died.
Codex Telleriano - Remensis

...It stopped raining The Mexicans became much disturbed because of hunger and the Mexicans did not go to their fields anymore
Anales de Tlatelolco - Codice de Tlatelolco

In this year everything became bad (todo se aconejo). There was then the war of the Chalcas in the margins of the mountains and it ended for this reason, there was no more war. There were three years of hunger; there were no provisions...
Codice Chimalpopoca - Anales de Cuauhtitlan

It is said that this year, 1 Rabbit, was an extremely unfortunate one; there were many deaths. The people died of thirst. From Chalco came foxes, ferocious beasts, lizards, etc., and they devoured the people. The famine was so great that the old Mexicans sold themselves; they took refuge in the woods where they lived unhappy and feeble. For four years there was nothing to eat in the country, so that the older Mexicans sold themselves and two divisions, it is said, delivered themselves into servitude. It is for this reason that the Totonacs came to buy Mexicans with maize, and it was to Cuextlan that they brought maize to the Mexicans. Up to that time they had not as yet had the custom of using maize bread. They put themselves into holes and died in any place they found and the lizards devoured them, for there was no one to bury them...
Annals of Chimalpahin

The Tezcucans began to construct the aqueduct to Chapultepec.
Annals of Chimalpahin.

It was in this year that it was said: "people became scared (La gente se aconejo)" as the ancient ones were wont to say everywhere, during which year there was nothing to eat. Because of this, the old Mexicans sold themselves. The trees known as "wide tree" and "yellow tree" were brought to all villages (for sustenance). A great many people died in all parts of the country and there was much suffering because of the attacks of beast and carnivorous animals. Also to indicate that "people became scared" another expression was used: "people became Totonacs" because the Totonacs bought with maize the Mexicans; to Cuextlan went the Mexicans to sell themselves in exchange for maize; while rain (was) absent, this was the usual currency.
Relations of Chalco Amaquemecan - Third Relation

This is the year in which it was said that people "became scared" (gente se aconejo) for reason of a great mortality, pestilences, and hunger. Coyotes, ferocious beasts and birds of prey came all the way to Chalco in search of people to attack. Such was the hunger that the ancient Mexicans sold themselves as slaves to obtain something to eat. Others went into the hills trying to escape the aridity and dryness which affected the vegetation and there they tried to plant something with their hoes. Certainly, there was nothing to eat and because of this the old Mexicans sold themselves as slaves in exchange for food. Thus another kind of people arose with those who "became Totonacs" (atotonacados) because a great number of said Totonacs bought Mexicans in exchange of dry maize, shelled, both in Cuextlan where Mexicans went to sell themselves and in Tenochtitlan where dry shelled maize was brought to buy them, but even with tortillas folded and dipped into something, there was not enough to go around and for this reason some people simply made holes in the ground and crawled into them to await death and when it came they were devoured by buzzards because there was no one to bury them. There was some relief in only those parts of the country where some rain fell.

Relations of Chalco Amaquemecan - Seventh Relation

1455
2 Reed

It was the second year of hunger which became (even) more serious.

Codice Chimalpopoca - Anales de Cuauhtitlan

It rained and the cycle of years was completed and since it rained nobody planted. Maize, chia, pigweed, squash which nobody had planted germinated everywhere; they germinated in the woods and in the paths.

Anales de Tlatelolco - Codice de Tlatelolco

Then it rained a great deal and there was an abundance of food.

Annals of Chimalpahin

Abundant maize crop.

Codex Telleriano-Remensis

This year it rained abundantly and a great quantity of food was produced.

Relations of Chalco Amaquemecan - Third Relation

1456
3 Flint

In this year (only) the pigweeds grew which were the only thing that was eaten and because of this there was a great mortality. It was the third year of hunger.

Codice Chimalpopoca - Anales de Cuauhtitlan

Mice devoured many things.
Annals of Chimalpahin

This year there was a great abundance of maize, fruits and all kinds of food (but) there were also many epidemics and disease. ....There was also then a great plague of mice which ate everything.

Relations of Chalco Amaquemecan - Third Relation

There also came then a great plague of mice which ate everything.
Relations of Chalco Amaquemecan - Seventh Relation

1460
7 Flint

...an earthquake occurred
Codex Telleriano-Remensis

1464
11 Flint

...the wind carried away maize plants which (at that time) had not set ears as yet; and trees were uprooted...
Codice Chimalpopoca - Anales de Cuauhtitlan

It was then that heat became stronger, that to say "it rained fire": there was no wind but when it came, it uprooted the large trees.

Great drought also occurred then and the heat of the sun caused much affliction. It was not possible to plant anything; great gusts of wind, as if caused by the devil, uprooted large trees.
Relations of Chalco Amaquemecan - Seventh Relation

1465
12 House

For the first time public works were begun in Tenochtitlan. The aqueduct of Chapultepec which enters Tenochtitlan was begun.
Codice Chimalpopoca - Anales de Cuauhtitlan

1466
13 Rabbit

....water for the first time entered Tenochtitlan (from Chapultepec)....
Codice Chimalpopoca - anales de Cuauhtitlan

The water of Chapultepec was brought into Mexico. The Texcucans under Nezahualcoyotl brought it. The aqueduct was finished after 13 years of work.
Annals of Chimalpahin

1467
1 Reed

In the year 132 (after the foundation of Tenochtitlan) there was an intense frost and famine. So great was the famine that in the following year it was decreed that whosoever should take an ear of maize, even if he took from his own field, should be punished by death.
Historia de los Mexicanos por sus pinturas

1475
9 Reed

There were then strong earthquakes, so frequent and repeated that hills broke up into pieces, the house was buried.

Relations of Chalco Amaquemecan - Third Relation

1479
13 Reed

Then there were many earthquakes; many houses collapsed, many walls fell, many hills were also broken up.
Relations of Chalco Amaquemecan - Seventh Relation

1484
5 Reed

This year the waters of Chiyappan became stagnant.
Codice Chimalpopoca - Anales de Cuauhtitlan

1488
9 Flint

A plague of locusts appeared then in Chalco forming clouds which thickened and stretched out and which, as it is known from the ancient ones, disappeared within the crater of Popocatepetl. They consumed all the ears of maize.
Relations of Chalco Amaquemecan - Seventh Relation

1490
11 Rabbit

During this year hail fell killing many fish; it caused all the animals which inhabit these waters to move elsewhere.
Relations of Chalco Amaquemecan - Third Relation

Hail fell in Mexico. There was such a heavy frost that all fish, little animals, and little beasts which live in water or swim in it, died.
Relations of Chalco Amaquemecan - Seventh Relation.

1491
12 Reed

Plague of grasshoppers.
Noble y Lebrija

A plague of grasshoppers came this year. The locusts ate everything.....

1492
13 Flint

This year an eclipse occurred which brought many sufferings and hunger. The people "became Totonacs" (la gente se atotonaco), because they went to Cuextlan to bring maize, when the eclipse occurred....In the same year in Amecameca the hill called Ixmatlatzin crumbled away which was located between Iztaccihuatl and Popocatepetl, Much water flowed when the hill collapsed and great number of savage beasts appeared and many of them devoured little children.
Relations of Chalco Amaquemecan - Third Relation

The hill Ixmatlatepetl collapsed and a great amount of water issued forth from it flooding Amaquemecan Chalco.
Relations of Chalco Amaquemecan - Seventh Relation

1496
4 Flint

In this year Xochtlan was depopulated by pestilence. There was also in the same year a solar eclipse.
Codice Chimalpopoca - Anales de Cuauhtitlan

In this year there was a solar eclipse....There were also earthquakes which destroyed houses. The ground opened in many places.
Relations of Chalco Amaquemecan - Third Relation

In this year there was an eclipse of the sun and stars could be seen. There were also earthquakes which ruined houses. The ground opened up in many parts.
Relations of Chalco Amaquemecan - Relation.....

1497
5 House

During this year Tequantepec, as well as Amaxtlan, were depopulated.
Codice Chimalpopoca - Anales de Cuauhtitlan

1498
6 Rabbit

This year the Huexotzingas were freezing in Coatepec, at the time of a snowfall.....
Codice Chimalpopoca - Anales de Cuauhtitlan

Floods.
Noble y Lebrija

1499
7 Reed

In this year the spring which comes forth in Coyoacan was channelled into the city (of Mexico)
Codice Chimalpopoca - Anales de Cuauhtitlan

This was the year in which the aqueduct (from Coyoacan) abandoned its bed and flooded the Mexicans.
Relations of Chalco Amaquemecan - Third Relation

Flooding in Mexico City.
Relations of Chalco Amaquemecan - Seventh Relation

1500
8 Flint

In the same year the aqueduct (acuecuexatl) finally broke down and flooded everything reaching to Cuitlahuac, Mizquic, Ayotzingo and Xochimilco; it also reached Tepetzingo at the outskirts of Texcoco and reached Xalmimilco and Matzatzintamalco. All of Mexico was flooded.
Codice Chimalpopoca - Anales de Cuauhtitlan

A wall of stone was erected in water....
Anales de Tlatelolco - Codice de Tlatelolco

1501
9 House

....the water of the lagoon rose to such a height, especially the Cuinacan River, that all the houses were submerged and the water actually reached as far as the first wall of the temple of Uchilobi. The houses made of adobe collapsed. It was said that the water was black and full of snakes.
Historia de los Mexicanos por sus pinturas

1502
10 Rabbit

At the beginning of the same year it stopped raining (and did not rain again) until we reached the year 1 Rabbit during which (time) there was hunger.
Codice Chimalpopoca - Anales de Cuauhtitlan

1503
11 Reed

...heavy snow fell in Tlachquiaco in the province of Mixteca
Codice Telleriano-Remensis

Drought
Noble y Lebrija

1505
13 House

There was a great famine in the province of Mexico and Mexicans went all the way to the province of Pango to get bread....
Codice Chimalpopoca - Anales de Cuauhtitlan

....at this time there was much hunger and maize was brought from Totonicapan....
Anales de Tlatelolco - Codice de Tlatelolco

Drought.

Noble y Lebrija

1506
1 Rabbit

....an aqueduct was built in Chapultepec.
Anales de Tlatelolco - Codice de Tlatelolco

In the year Zozollan was depopulated in one day as a result of pestilence.
Codice Chimalpopoca - Anales de Cuauhtitlan

There was a plague of rats in the province of Mexico. The rats ate all that was planted and the people had to get up at night, therefore, with torches and walk through the planted fields.
Codice Telleriano-Remensis

1509
4 House

Also during the said year, as it can be seen in the paintings of the Ancient Amaquemes, a terrifying phenomenon began to be observed in the sky; a wind of oblong and fusiform shape, extremely dark and dense, like a cloud, descended from the center of the sky, and this phenomenon could be seen from all parts of the country.
Relations of Chalco Amaquemecan - Seventh Relation

In the Mexicans records it is affirmed that they saw appear in the sky a kind of cloud which was appeared to be originating in the sky and emitted light and radiance and this same phenomenon was soon everywhere; and the people were extremely worried and afraid because of this kind of rainbow of clouds of light which appeared.
Relations of Chalco Amaquemecan - Seventh Relation

1511
6 Reed

In this year there were severe snowstorms and three earthquakes.
Codice Telleriano-Remensis

1512 7 Flint	...the stones steamed to such an extent that (the steam) seemed to ascend the sky. Codice Telleriano-Remensis
1517	Sudden Flood; the lake rose without any mention of rains. Probably a long period of precipitation in the surrounding mountains was the cause. Lorenzo
1518 13 Rabbit	The people of Tlaxcala approached those of Guaxocingo and told them that they were suffering from hunger. Historia de los Mexicanos por sus pinturas
1524	This year began a steady and noticeable decrease in the lake levels Lorenzo
1528	Heavy rains; maize fields ruined Gibson
1543	Great drought accompanied by dust storms. Lorenzo
	Drought, frosts; shortages of wheat and maize in November and December; famine. Gibson
1544-1545 13 Flint-11 House	There was a great mortality among the Indians. Violent wind blew down the trees Codex Telleriano-Remensis
	Shortages of wheat and maize in July after the frosts of 1543 Gibson
1552	Heavy rains; towns in the southeastern region of the Basin were flooded. Lorenzo
1553	Dry year; a sudden heavy shower flooded the city of Mexico Lorenzo
1555	The most important flood of Colonial times. On September 17 heavy rains covered the city of Mexico with 2m of water; the general situation was so bad that several families left and settled in Puebla permanently. The flood lasted several months. Lorenzo
1557	Locust plague. Gibson
1558	Locusts, frosts, shortages. Gibson

1559 Locusts in April.
Gibson

1562 Loss of maize in September
Gibson

1576 From the middle of September until the end of October frosts occurred in the Basin, especially heavy in the southeastern region.
Lorenzo

Epidemic.
Noble y Lebrija

Drought, prolonged heat in October; limited yield.
Gibson

1577 Continuous rains from April to November; fields excessively wet; harvests small.
Gibson

1579 Great famine; maize shortage
Gibson

1580 From December 1579 to January 1580 severe floods
Lorenzo

1587 Late rains: in July; famine in Mexico City.
Gibson

1589 A heavy snowfall covered the Basin for several hours.
Lorenzo

1590 Continuous heavy rains injurious to wheat.
Gibson

1591 Early rains followed by drought in June.
Gibson

1592 Locusts in May
Gibson

1594 Drought and frosts.
Gibson

1597 Frosts and drought to middle of August; harvest poorer than expected.
Gibson

1599 Rains delayed in spring; early frosts in autumn.
Gibson

1600 Heavy rains but scanty harvest.
Gibson

1601 — Plentiful maize harvest everywhere.
Gibson

1604 — Maize dessicated.
Gibson

1606 — Rains in July; early harvest.
Gibson

1609 — Limited harvest and short supply.
Gibson

1610
1 Rabbit — It was in this year that in all parts, in settlements and forests, frosts (snows) fell, which did not occur every year. Toward the end of January there was a strong wind which everywhere overthrew trees and the rocks were moved from their place by the wind. Horses and other animals died as the result of the frost as well as the donkeys.
Relations of Chalco Amaquemecan - Sixth Relation

1616 — Late rains; drought. extreme shortages.
Gibson

1617 — Abundance of maize and wheat.
Gibson

1618 — Drought in July.
Gibson

1620 — Drought; serious maize shortages.
Gibson

1621 — Drought; maize shortages.
Gibson

1624 — Most severe drought yet known; in June.
Gibson

1627 — Rains; abundant year.
Gibson

1639 — Drought.
Gibson

1641 — Extreme drought; failure of spring rains.
Gibson

1642 — Drought and famine; continued maize shortages.
Gibson

1653 — Drought in June.
Gibson

1661	Drought in June; followed by early autumn frosts; great shortages. Gibson
1662	Continued shortages. Gibson
1663	Great drought; famine; heat; frosts in late spring. Gibson
1665 Sept. 28	Heavy frost causing much damage. Robles
Oct. 31	Heavy frost; much damage. Robles
1667	Drought in May and June. Gibson
May 11	This day Our Lady of Remedies was brought from the sanctuary to ask her to make it rain and to stop the diseases from which many people were dying. Robles
1668	Drought in June. Gibson
June 13	Our Lady of Remedies came to Mexico because there was much illness and lack of water; and the same day it began to rain from 2 p.m. until 6 p.m. and it continued afterwards. Robles
1672 July 30	It rained Robles
1673 June 10	It rained three quarters of an hour. Robles
1674 October 4	It rained so much that the little bridges of S. Antonio were flooded as well as those near Tacuba and S. Cosme. Robles
1675 July 5	Heavy rain north of Mexico City. Robles
Aug. 12	It rained Robles
Sept. 5	The day began with rain which lasted ten hours. Robles
Nov. 2-3	It rained heavily until 4 p.m. of Nov. 3. Robles

1677 May 14	At 10 a.m. a beautiful halo appeared surrounding the sun. Robles
1678	Drought until June. Gibson
June 17	It rained for several hours through the intercession of Our Lady of Remedies. Robles
June 19	It rained from 2 to 3 p.m. Robles
June 25	It rained from 1 p.m. of this day (Saturday) until Sunday. Robles
Aug 17	News came from the outlet (of the Basin of Mexico) that such a large body of water reached there that it carried away all the soil and left a large opening. Robles
1679 March 27	A downpour took place from 7 to 9 p.m. Robles
March 30	A downpour with hail fell most of the night. Robles
March 31	It rained at the same hour, the sky clearing later. Robles
Aug. 12	Four downpours occurred Robles
1680 October 18	It rained Robles
1681 June 23	It stormed Robles
June 24	The earth trembled...after the rain and there was much wind. Robles
Dec.	The day began with a rain which lasted until 2 p.m. Robles
1683 June 11	The day (Friday) began with a rain which lasted until Saturday (June 12) 8 p.m. Robles

1684 Dec. 4	At about the time of the prayer (6 p.m.) a kind of dense dust of salt or salpeter came over the whole city which lasted until 8 p.m.....it was said that this dust comes from the Tequesquite lagoon. Robles
1685 June 24	The day began with rain. Robles
Aug. 21	Hail, the size of cacao seeds, fell for about an hour and a half. Robles
1686	Drought until June. Gibson
June 20	The procession of the eighth day of Corpus did not follow the usual route because of the heavy rain the day before. Robles
July 5	Five large downpours fell in the afternoon. Robles
1687 Jan. 2	It rained at about 10 a.m. Robles
Feb. 1-2	It rained day and night. Robles
1691	Heavy rains; losses in all crops. Gibson
May 29	It rained all day Robles
June 14	The day of Corpus Christi, since it had rained for three days with their nights, on account of so much mud and water....the viceroy was consulted whether the procession should take place....it rained all afternoon and night. Robles
June 15	It dawned raining until 8 a.m. and then it rained from 3 to 6 p.m. Robles
June 16	It rained and the bell was rung to make it cease. Robles
June 21	Octava of Corpus; the procession was held within the church because of the mud and because the viceroy and the archbishop were ill. Robles

June 23

Another bridge in the causeway of Guadalupe was ordered open and the floodgate of Villalegua was opened again.
Robles

After the eclipse of Aug 23, a plague developed in the fields of wheat and maize which they call chahuistle, which is a worm in the root and as a result the harvests were very short, from which originated shortage of provisions and from it hunger and mortality of people in the whole of New Spain; and it lasted until most of the following year...
Robles

1692

Extreme shortages; famine
Gibson

Jan. 3

There was lack of meat in butcher shops and slaughterhouses.
Robles

Jan. 22

The price of wine went up to seven reales.
Robles

March 9

An edict was promulgated prohibiting the Indians to make hosts (the eucharistic wafers), reserving this to the sextons only....this was ordered for fear that they would mix wheat flour with other kinds because of shortage.
Robles

April 4

Today it rained all afternoon.
Robles

May 6

Today is was proclaimed that all sell their maize and wheat.
Robles

May 20

Special prayers began in the cathedral and the other churches because of lack of water and because of illness.
Robles

May 29

Our Lady of Remedies was carried to the convent of S. Bernard and it rained from 6 to 9 p.m.
Robles

June 1

Today in the afternoon, the third rain fell since the Holiest Virgin, Our Lady of Remedies came to Mexico.
Robles

June 8

An upheaval of Indians in the City of Mexico occurred. The reason for this disturbance was the shortage of maize and other provisions. The palace of the viceroy was burned.
Robles

July 1	It was ordered that there be no hucksters of seed. Robles
July 6	The edict of the archbishop against seed hucksters was read Robles
July 12	An edict was promulgated making the Indians move to the outskirts.
July 19	It was ordered that no pulque be sold or made in the whole of New Spain Robles
	It was ordered that in the Plaza only pulque without root (which is medicinal) be sold. Robles
Sept. 1	It rained very heavily Robles
Sept. 16	There was no bread Robles
Sept. 21	During these days there was a general epidemic of measles in Puebla; in one parish only, 3000 children have died. Robles
Sept. 27	Prayers against the plague were begun Robles
Oct. 16	No burial took place in the cathedral Robles
Nov. 14	Today there was neither charcoal nor wood; hens cost seven reales, chickens three.....bread is very expensive. Robles
Jan 16	Permission was given to plant white wheat (amaranth) to those who wished to do so and all censures prohibiting it were abolished Robles
1693	Shortage of maize Gibson
1694 April 17	Today at 6 p.m. there was a terrible storm; 17 lightning bolts hit. Robles
June 18	It began to rain from 10 p.m. and it rained until 6 a.m. Robles

November 22-23	There was a shortage of maize in the public granary Robles
1695	Drought; frosts in September; great shortages of maize. Gibson
April 6-7	There was no maize in the public granary Robles
May 13	Maize is becoming scarce and expensive. Robles
May 17	Large loafs of bread are beginning to be sold. Robles
July 1	It was ordered that, beginning with tomorrow, the bakers sell bread for half (real) per pound. Robles
July 18	It rained heavily in the afternoon. Robles
Nov. 20	It rained all day and dense snow fell resembling feathers; very cold. Robles
Sept. 13	Frost began and there was a general lack of water Robles
1696	Maize extremely scarce throughout the year Gibson
April 30	Maize again became very costly; one fanega costs five pesos; the Indians went to see the viceroy and the Indians from the country are coming into Mexico City to beg alms because they are starving. Robles
May 7	Prayers were begun in the cathedral because of lack of water. Robles
May 24	At 3 p.m. fell a heavy downpour. Robles
1697	Continued serious shortages. Gibson
1699 May 13	S. Bernard was proclaimed patron saint of this city (Mexico) against "chahuistle" (a worm attacking roots of crops). Robles
1700 April	During this month there was a great illness called "pitiflor" of which many people died. Robles

June 9	At 4 p.m. such a downpour fell that streets were flooded; it lasted until 11 p.m.
1702	Drought in June. Gibson
July 26	After 3 p.m. a very great hurricane began from all four sides which lifted such a great cloud of dust that the sun disappeared; it lasted until about 5 p.m. Robles
1703 March 4	At 3:30 p.m. a heavy downpour fell with a storm of large hailstones and it lasted for about one hour. Robles
Aug. 24	The floodgate of Chapultepec broke and flooded all gardens (chinampas) and the church of S. Diego, a suburb of this city. Robles
1705	Drought in May. Gibson
1711	Drought. Gibson
1713	Drought and shortages Gibson
1720	Drought in June. Gibson
1741-1742	Reduced harvests. Gibson
1747	Heavy rain. Gibson
1749	Great drought and early frosts in the interior and north; less severe in the Basin of Mexico. Gibson
	Early frosts; crops ruined. Noble y Lebrija
1752	Rains and abundance. Gibson
1755	Drought in June. Gibson
1762	Abundant rains. Gibson
1763	Abundant rains. Gibson

1764 Drought but not severe enough to cause shortages.
Gibson

1765 Early drought followed by insufficient rains.
Gibson

1766 Abundant rains.
Gibson

1768 Drought and rain out of season; disease in wheat; shortages of all grains.
Gibson

1769 Shortages of wheat and beans, but sufficient maize.

1770 Drought; disease in wheat; reduced harvests.
Gibson

1771 Rainy season delayed; rains intermittent; frosts in mid-October before maize reached maturity; wheat plentiful but shortage of maize.
Gibson

1772 Drought in June; excessive rains in August and September.
Gibson

1773 Drought; frost in May; only immature ears harvested in some areas.
Gibson

1778 Drought in June.
Gibson

1779 Drought in June.
Gibson

1780 Drought and frosts.
Gibson

1784 Freeze in August causes destruction of corn and bean crops of the plateau causing the death by starvation of about 300,000 people.
Noble y Lebrija

1785 Rainy season delayed; drought in May; almost all maize destroyed by severe frost on August 27; shortages begin in September.
Gibson

1786 Continued shortages; "Ano de hambre"; abundant harvest late in the year.
Gibson

1789	Abundance of wheat and maize. Gibson
1853 Aug. 24	A heavy downpour over the hills of Mixcoac caused the river to abandon its bed flooding planted fields and destroying several houses. Noble y Lebrija
1854 May 19	Between 3 and 4 p.m. a strong wind blew from the southeast, which growing by degrees, became a powerful hurricane and ruined the triumphal arch. Noble y Lebreja
1855 July 12	The village of Meztitlan (Hidalgo) was flooded as a result of rains. These began the 7th of June and lasted for 43 consecutive days. Many plantings and deposits of grains were destroyed. Noble y Lebrija
1858 Feb. 23	During this time there were strong winds; today wind ruined huts and threw down the lampost installed in the middle of the principal plaza, breaking the iron post that was holding it up. Noble y Lebrija
1860 Aug. 25	An edict of the district government decreeing tariff on foodstuffs because of their scarcity. Another edict imposed a tariff on bread. Noble y Lebrija
Sept. 16	A heavy rain with hail fell causing havoc in the Alameda because people could not leave in time. Noble y Lebrija
1865 Aug. 3	The Emperor, in person, accompanied by the Municipal President and various engineers, visited the flooded parts of Mexico City. Noble y Lebrija
Aug. 29-31	Several heavy downpours occurred, especially the last day, which caused the flooding of many streets which remained under water for a long time. The entire year was extremely rainy. Noble y Lebrija
Sept. 5	At 6:30 p.m. there appeared in the direction of the volcanoes one of the most imposing meteoric phenomena called "manga de agua." Great electric discharges made it disappear. Noble y Lebrija
1866 May 21	A letter was sent by the Emperor to the ministry of interior dealing with remedies for the lack of food-stuffs, especially of meats. Noble y Lebrija

1868
Sept. 15 — A decree was issued permitting the importation of maize from the exterior through the port of Campeche.
Noble y Lebrija

1869
June 17 — A downpour in the ravine of Otuma destroyed the embankment of the railroad to Apizaco. The coaches and the locomotive fell into the ravine.
Noble y Lebrija

1874
Jan. 6 — During this time much cold weather was felt along the road to Toluca; ten Indians die of cold and deer are abandoning the mountains in hundreds.
Noble y Lebrija

May 30 — A downpour in Palmillas causes the flooding of Apizaco bringing much destruction.
Noble y Lebrija

July 2 — River Consulado leaves its bed, flooding adjacent lands, that is, the hacienda Condesa and the causeways Colonia and Arquitectos.
Noble y Lebrija

July 21 — The streams of Atzcapotzalco and of Cuautitlan overflow destroying maize fields.
Noble y Lebrija

1876
July 22 — There was such a strong storm in the eastern part of the city that, according to the newspapers, the houses could be felt shaking.
Noble y Lebrija

1878
Aug. 13 — Between Toluca and Mexico City a downpour destroyed an embankment for about 100m.
Noble y Lebrija

Aug. 15 — As a result of strong and continuing rains all rivers descending in the Basin are very high.
Noble y Lebrija

Aug. 31 — The heavy rains that have occurred during this month have caused much damage and discomfort. Among the many places so affected is San Juan Teotihuacan.
Noble y Lebrija

Sept. 1 — A big storm in Tizayuca (Hidalgo) causing the death of three persons.
Noble y Lebrija

1880
July 28 — A storm occurred in Tula, Hidalgo; the river left its bed destroying several houses and killing seven persons.

1881
Jan. 5 — Frost hits Toluca and vicinity; it was so intense that apart from damaging plantings, it caused the death of railroad workers.
Noble y Lebrija

Feb. 7	Heavy winds in Mexico City. Noble y Lebrija
Feb. 8	Heavy snowfall in the Plains of Apam and also in Toluca; the snow was 3 feet (36 cm) deep. Noble y Lebrija
June 23	Hail destroyed many plantings in the vicinity of Huexotzingo, Puebla. Noble y Lebrija
Aug. 2	A downpour made the Consulado River flood adjacent areas. Noble y Lebrija
Oct. 24	Hail that fell between the haciendas of San Miguel and of Cuautla destroyed chile plantings. Noble y Lebrija
1882 March 5	Hail in Mexico City; some roofs collapse under the weight of ice. Noble y Lebrija
May 31	Heavy rains in Pachuca; floods cause the death of several persons. Noble y Lebrija
June 30	Heavy rains and floods in Mexico City; floods in Pachuca.
1883 Feb. 28	Heavy storms in the state of Mexico disrupt telegraphic service. Noble y Lebrija
1884 Sept. 27	Heavy floods in Pachuca reaching the height of 2m Noble y Lebrija
1885 Oct. 3	Heavy rains that fell in the afternoon in Mexico City caused serious flooding in various sectors and the collapse of several houses. Noble y Lebrija
1886 Sept. 25	Again heavy rains in Mexico City; it is estimated that more than 300 houses were damaged. Noble y Lebrija
1888 Aug. 14	From 4 p.m. until late at night heavy rains occur in Mexico City, causing flooding in the entire city. The merchants of the street of Refugio and adjacent streets suffer many losses. Noble y Lebrija
Sept. 7	Floods in Pachuca. Noble y Lebrija

1890 Feb. 8	Heavy snow in Pachuca and in San Luis Potosi. Noble y Lebrija
1892 June 18	Promulgation of the decree permitting free importation of maize and beans from the exterior. Noble y Lebrija
1893 March 10	Extension of the decree of June 18, 1892. Noble y Lebrija
1894 Jan. 8	Dust storms occur in Mexico City. Noble y Lebrija
1895 July 4	Floods in Pachuca with consequent losses. Noble y Lebrija
July 6	Floods north and northwest of Mexico City, particularly in Tlalnepantla and Villa de Guadalupe. Noble y Lebrija
Aug. 21	More floods in Pachuca Noble y Lebrija
1902 April 9	Shortly after 3 p.m. heavy hail fell in Mexico City causing many accidents. The following morning in many parts of the city the ground was still covered with ice. Noble y Lebrija
1904 June 27	A cloudburst in the vicinity of Mexico City; la Piedad was flooded; water reached 1.50m. Noble y Lebrija
July 2	Floods in Mexico City and various settlements of the Federal District. Noble y Lebrija
Aug. 11	The Consulado River floods Santa Julia and San Rafael, in Mexico City. Noble y Lebrija
1905 Jan. 14	Snowfall in Chapultepec, San Angel. Tizapan, and Ajusco. Noble y Lebrija
1906 Jan. 24	Snow fell in Mexico City causing much damage in gardens in the vicinity. Noble y Lebrija
Aug. 1	Dust storm in Mexico City. In the afternoon the sky was completely dark. Noble y Lebrija
Aug. 7	In the states of Puebla, Tlaxcala, Hidalgo, Mexico, Morelos, and Michoacan a plague of worms destroys plantings in a matter of a few hours. Noble y Lebrija

1907 Feb. 11	At dawn a snowfall occurs in Mexico City as well as in Toluca and Pachuca. Noble y Lebrija
1908 May 22	In Tulancingo a storm that took place at 2 p.m. which lasted 2 hours, causes much damage to crops. Noble y Lebrija
June 7	Many floods were caused by heavy rains in the states of Coahuila, Nuevo Leon, Hidalgo, Mexico, Puebla, Oaxaca. Noble y Lebrija
1909 March 5	Strong winds in Toluca cause panic among the inhabitants. Noble y Lebrija
Sept. 28	Heavy frosts in the Republic cause a great loss in crops. Noble y Lebrija
Oct. 8	A decree was issued permitting duty free importation of maize until March 1911 because of the sufferings of poor people. Noble y Lebrija
Oct. 20	The Executive was authorized to expend the amount necessary for the importation of maize and beans from the exterior. Noble y Lebrija
1910 March 10	A decree was issued extending until Sept. 30, the decree relative to importation of maize. Noble y Lebrija
1915 Sept. 30	During the afternoon and evening of this day many streets of the City of Mexico are flooded because of torrential rains. Noble y Lebrija
1916 Sept. 19	As a result of the torrential rains which had been falling since the night of Sept. 17 in the Basin of Mexico, the Consulado River floods Colonia Vallejo. Noble y Lebrija
1917 Feb. 20	Strong winds in Mexico City uproot a number of trees. Noble y Lebrija
1918 Aug. 1	A heavy storm in Pachuca floods all streets and causes many adobe constructions to collapse. Noble y Lebrija

1919 Jan. 24	Strong winds in the Basin of Mexico cause many trees to be uprooted in the Desierto de los Leones. Noble y Lebrija
March 25	Strong winds blow in Mexico City and in the Federal District causing damage in various parts. Noble y Lebrija
1921 Jan. 18	A big flood in Pachuca, Hidalgo; the dam "El Sotol" was destroyed causing the water to descend on the town; more than 50 corpses were found. Noble y Lebrija
May 4	Heavy storm in Mexico City; many houses were seriously damaged. Noble y Lebrija
Feb. 19	Due to the lack of electric power, clocks are advanced sixty minutes. Noble y Lebrija
Oct. 4	Clocks are returned to standard time. Noble y Lebrija
1924 June 6	Heavy rains in the afternoon cause the flooding of the principal streets in Mexico City. Noble y Lebrija
July 17	Heavy rains and hail cause the flooding of Mexico City. Noble y Lebrija
1925 Jan. 23	Intense snow falls for three days in the Desierto de los Leones. Noble y Lebrija
Aug. 1	Various sections of Mexico City were flooded. Noble y Lebrija
Sept. 19	Floods in Pachuca (Hidalgo) Noble y Lebrija
1926 July 5	Villa de Guadalupe was innundated; water reached in some streets more than 2m. Noble y Lebrija
1927 Jan. 16	Cold wave in Mexico City, the temperature descending to -5 degrees C Noble y Lebrija
March 27	A damaging hail fell in Tulancingo, Hidalgo; hail was 3 to 4 cm in diameter. Noble y Lebrija

May 10	Heat wave in Mexico City; the temperature reaches 34 degrees C in shade. Noble y Lebrija
Sept. 7	A storm floods Mexico City. Noble y Lebrija
1928 Jan.10	An intense cold wave in Mexico City causes the death of several persons. Noble y Lebrija
1930 Oct. 6	Heavy storm floods Pachuca, Hidalgo Noble y Lebrija
Oct. 20	Continuing torrential rains flood Pachuca, Hidalgo Noble y Lebrija
Oct. 23	Tulancingo Hidalgo, flooded. Noble y Lebrija
1931 July 7	The stream and La Magdalena causes the flooding of San Angel, Mixcoac, Coyoacan, and General Anaya. Noble y Lebrija
Dec. 20	The temperature descends to -4 degrees C in the Federal District causing the death of several persons. Noble y Lebrija
1932 June 24	Rains begin in the Basin of Mexico. Noble y Lebrija
June 30	The drought which has afflicted most of the country, has been extreme; it augurs very poor crop yields. Noble y Lebrija
Oct. 4	A cold wave on the Central Plateau causes the death of several poor persons. Noble y Lebrija
Oct. 14	Torrential downpours cause flooding in Mexico City. Noble y Lebrija
Nov. 28	A cold wave in the Federal District makes the temperature to descend to -6 degrees C. Noble y Lebrija
Dec. 23	Another cold wave on the Central Plateau; the temperature falls to -10 degrees C. Noble y Lebrija
1933 May 5	Heat wave in the Federal District (33 degrees C). Noble y Lebrija

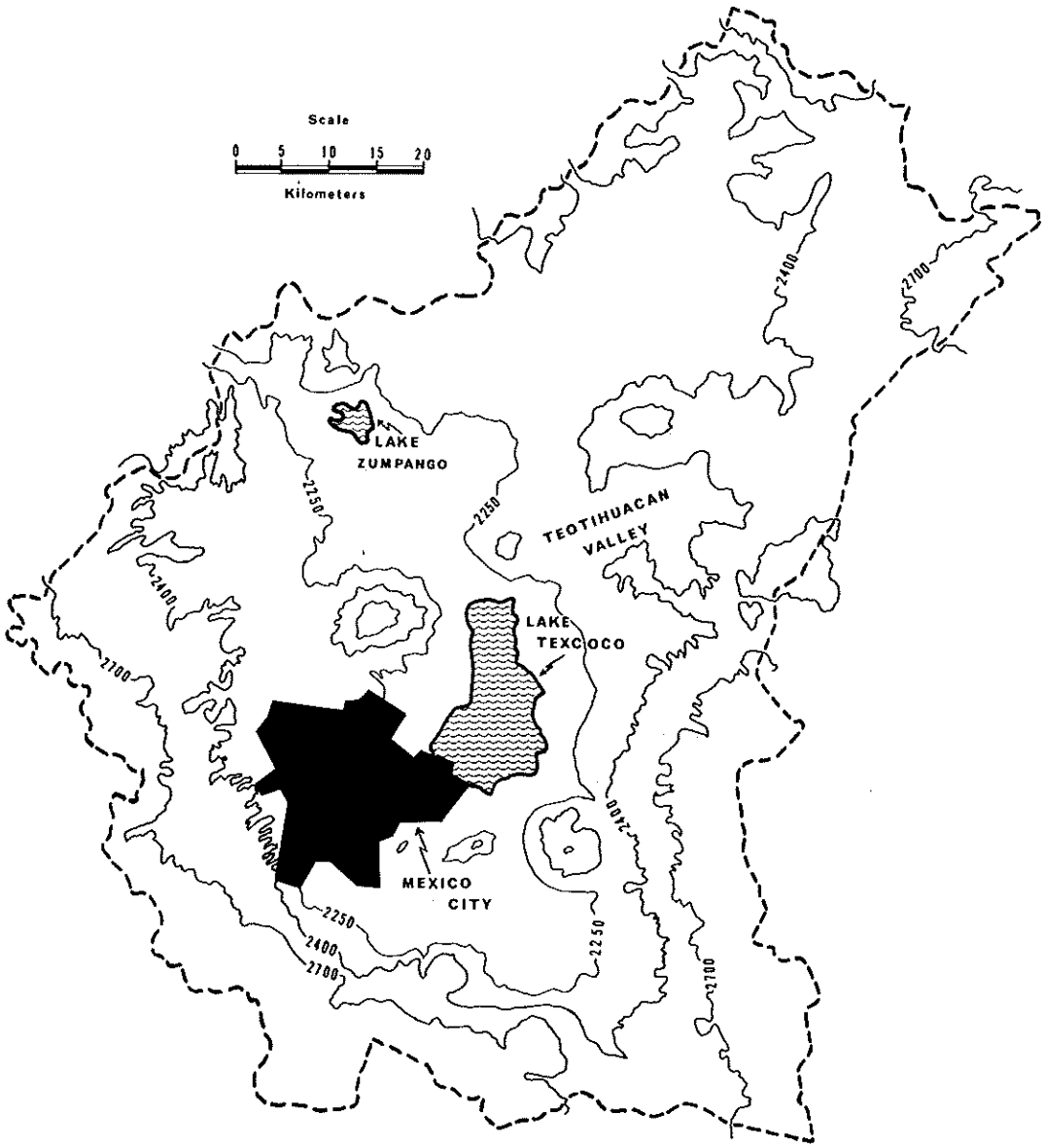
Aug. 29	El Consulado and Los Remedios rivers cause flooding in Mexico City. Noble y Lebrija
Nov. 16	Intense cold wave in the Basin of Mexico. Noble y Lebrija
1934 March 11	Cold wave (-6 degrees C) in the Central Plateau causes considerable damage. Noble y Lebrija
June 20	A hailstorm in Texcoco causes serious damage. Noble y Lebrija
Aug. 20	Torrential rain, accompanied by hail fell in Mexico City causing landslides and floods in the Colonias Juarez and Roma. Noble y Lebrija
1937 March 7	A protest march takes place in Mexico City because of lack of food. Noble y Lebrija
June 1	A downpour floods part of Mexico City. Noble y Lebrija
1938 Jan. 25	Intense cold wave on the Central Plateau. Temperature descends to -8 degrees C. Noble y Lebrija
Feb. 28	Free importation of maize is authorized. Noble y Lebrija
Nov. 24	Intense cold wave on the Central Plateau. Noble y Lebrija
Dec. 9	Another very intense cold wave on the Central Plateau. Noble y Lebrija
1939 Feb. 6	Low water level at the impounding dam of Necaxa where electricity for the city of Mexico is produced. To economize on electric power the clocks are advanced by one hour. Noble y Lebrija
June 25	Clocks are turned back Noble y Lebrija
Aug. 10	Torrential rainfall in Mexico City floods several streets for several hours. Noble y Lebrija

Oct. 9	Export of maize, beans, cattle, etc, prohibited. Noble y Lebrija
1940 Jan. 13	Export of rice, beans, basic materials for the production of medicines, prohibited. Noble y Lebrija
March 14	Heavy snowfall in the Basin of Mexico. Noble y Lebrija
Dec. 28	Intense cold wave (-6 degrees C) on the Central Plateau. Noble y Lebrija
Dec. 9	Measures to preserve electric energy are taken; clocks are advanced one hour in the Federal District. Noble y Lebrija
1941 Jan. 13	The supply of electric energy was suspended daily between 11 a.m. and 1:30 p.m. in the Federal district. Noble y Lebrija
March 31	Clocks are returned to standard time. Noble y Lebrija
May 8	The suspension of the supply of electric energy is ended. Noble y Lebrija
June 11	A cloudburst in the Serrania de Ajusco causes flooding in the Federal District by the rivers Churubusco, Remedios, etc. Noble y Lebrija
Sept. 3	A heavy hailstorm in Mexico City and its environs causing floods and the loss of many plantings. Noble y Lebrija
Sept. 21	An intense storm in Mexico City causes material damages; some people are hurt. Noble y Lebrija
Sept. 25	Rio Consulado causes floods in the northern part of the city; Ticoman destroyed by the Rio de los Remedios. Noble y Lebrija
1942 May 18	By decree the government takes over all the maize, beans and rice present and to be produced. Noble y Lebrija
Sept. 7	A prolonged downpour causes the flooding of a large part of Mexico City. Noble y Lebrija

Nov. 29	An intense cold wave results in heavy snowfall in the mountain ranges in the southern part of the Basin of Mexico. Noble y Lebrija
1943 June 8	Because of the lack of maize many mills of nixtamal have been paralyzed in the Federal District. Noble y Lebrija
Sept. 20	The price of food has been frozen by the government Noble y Lebrija
Nov. 10	During the last week an intense cold wave caused trouble in the Basin of Mexico. Noble y Lebrija
Dec. 15	Today at midnight clocks were set one hour ahead in order to save electricity (in the Federal District). Noble y Lebrija
1944 Feb. 7	It was ordered to save 20% of electric energy in all services of the Federal District. Noble y Lebrija
April 30	Daylight saving time ended in the Federal District. Noble y Lebrija
June 27	The restrictions of the use of electric energy are ended. Noble y Lebrija
Aug. 2	Torrential downpours flood the southern part of Mexico City. Noble y Lebrija
Aug. 30	Heavy rains in the city of Mexico cause floods and the collapse of two houses. Noble y Lebrija
Sept. 28	A storm in the Mexico City floods the central streets and causes damage in some colonias. Noble y Lebrija
1947 Aug. 12	Heavy storm in Toluca, the capital of the state of Mexico. Noble y Lebrija
Aug. 23	Partial flooding in the colonias of Valle, Alamos, Buenos Aires, by the river La piedad. Noble y Lebrija
Dec. 25	An intense cold wave with rain in the Valley of Mexico Noble y Lebrija

Dec. 28	A snowfall of 40 hours occurred in San Luis Potosi. Noble y Lebrija
1948 Jan. 14	An intense cold wave in the Central Plateau. Noble y Lebrija
Jan. 19	Abundant snowfall on the highway from Mexico City to Toluca. Noble y Lebrija
May 18	Torrential rainfalls flood various parts of the City of Mexico; water reached the height of 50cm. Noble y Lebrija
July 21	Floods in Mexico City causing losses amounting to several millions of pesos. Noble y Lebrija
1949 Jan. 1	Cold wave in the Federal District; eight people died. Noble y Lebrija
June 24	An intense storm in Pachuca, Hidalgo, causes 52 deaths, 200 wounded, and damages of several million pesos Noble y Lebrija
1950 Jan. 18	Restrictions are placed on the use of electricity. Noble y Lebrija
Feb. 12	Clocks are advanced an hour in the Federal District to conserve electricity. Noble y Lebrija
Feb. 23	A daily blackout of 45 minutes and Saturdays of three hours is ordered in order to save electricity. Noble y Lebrija
April 12	The Saturday blackouts are suspended. Noble y Lebrija
May 11	The daily blackouts are ended. Noble y Lebrija
June 19	As a result of heavy rains Rio Piedad overflows flooding Colonia Roma Sur. Noble y Lebrija
July 24	The Necaxa dam of the power plant of Mexico City holds 68 million cubic meters and this quantity is more than the double of what it held last year at this time. Noble y Lebrija

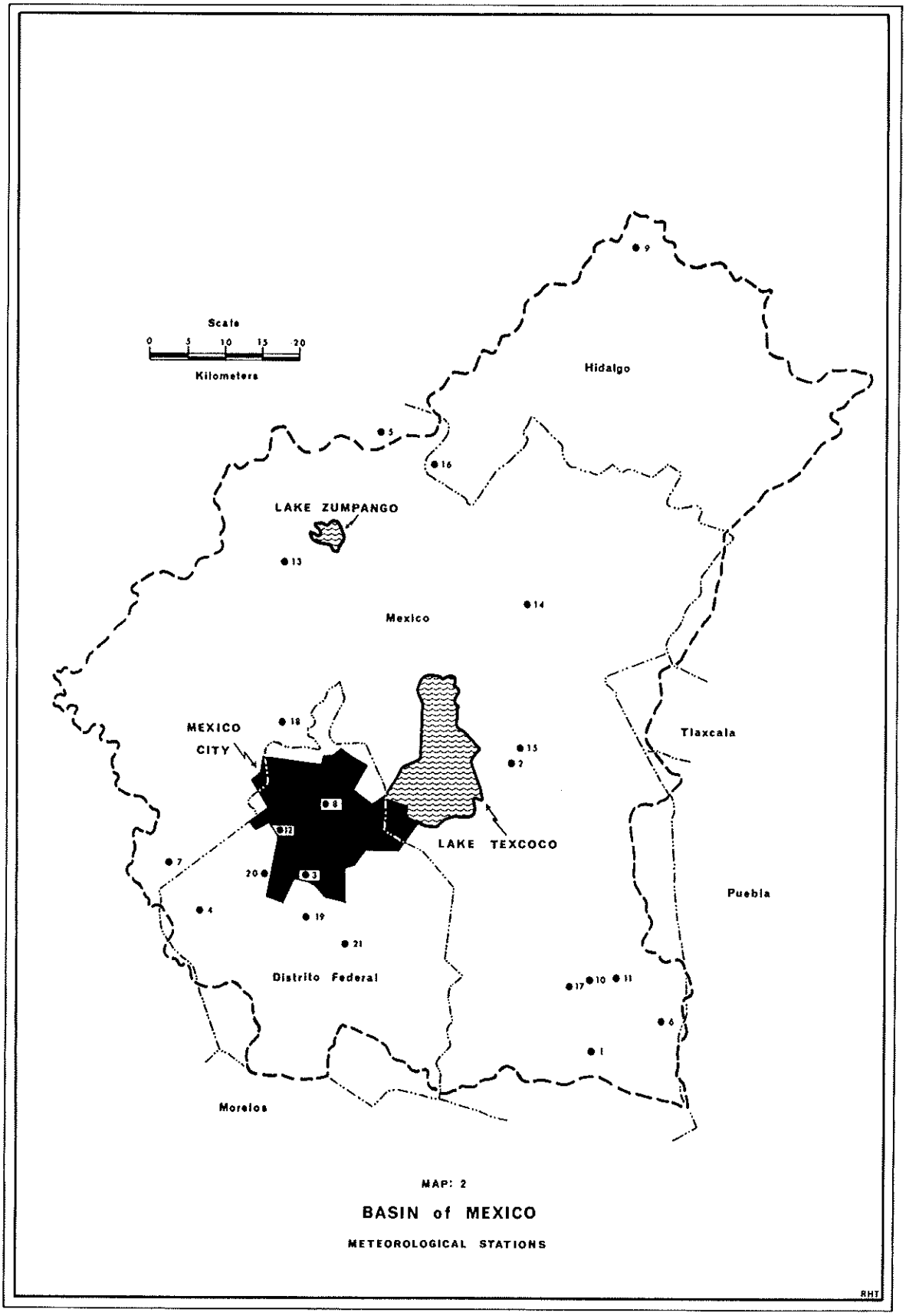
Sept. 8	Heavy floods in Mexico City, especially in the sectors North, Northeast and Center. Noble y Lebrija
Oct. 9	Again the City of Mexico is converted into a lagoon, as a result of the storm which lasted two hours in the Federal District. Noble y Lebrija
Nov. 24	Six dead persons were found in Mexico City as a result of low temperatures. Noble y Lebrija
1951 March 20	Torrential rain in Pachuca. Noble y Lebrija
May 5	A very heavy hail fell near Actopan, Hidalgo causing much damage to crops. Noble y Lebrija
May 21	Floods in Mexico City. Noble y Lebrija
July 9	A storm in Mexico City made water to rise up to 2m. Houses collapsed and at least 300 families were left homeless. Noble y Lebrija
July 28	A heavy storm caused serious damage in Teoloyucan, Mexico, trees were uprooted and several houses destroyed. Noble y Lebrija
Aug. 1	More Floods in Mexico City Noble y Lebrija
1962 July 15	Heavy rain and flood in San Juan Teotihuacan. Kovar
1963 May 7	Minor flooding in San Juan Teotihuacan. Kovar



MAP: 1

BASIN of MEXICO

ECOLOGICAL ZONES



MAP: 2

BASIN of MEXICO

METEOROLOGICAL STATIONS

	Elevation m	Average Annual Precipitation	Average Annual Evaporation	Average Annual Temp.	Extreme Maximum Temp.	Extreme Minimum Temp.	Range Av. Monthly Temperature	Extreme Temp. Range
1. Ameca meca, Mexico	2530	1363.8		14.9	30.0	-5.0		35.0
2. Chapingo, Mexico	2250	581.7	1701.1	14.9	34.5	-11.5	5.8	46.0
3. Coyoacan, D. F.	2240	707.5						
4. Desierto delos Leones, D. F.	3220	1281.4		11.3	29.6	-6.1	4.7	35.7
5. Huehuetoca, Mexico	2259	672.8						
6. Hueyatlaco, Mexico	3557	1155.0		7.8	20.2	-5.0		25.2
7. Huizquilucan, Mexico	2700	1158.6		13.7	31.7	-5.0	4.9	36.7
8. Mexico City, D. F.	2236	534.0		15.5	30.0	-0.2		30.2
9. Pachuca, Hgo.	2435	418.7	1424.0	14.2	31.4	-5.8	4.9	37.2
10. San Juan Guadalupe, Mexico	2494	1015.0		13.6	30.0	-3.5	4.7	33.5
11. San Rafael, Mexico	2530	1179.6	2521.0	13.2	31.3	-8.2	4.0	39.5
12. Tacubaya, D. F.	2309	767.1	1443.0	14.7	33.8	-4.2	5.8	38.0
13. Teoloyucan, Mexico	2285	663.4		15.3	35.5	-8.0	6.2	43.0
14. Teotihuacan, Mexico	2286	547.5	2210.3	14.4	38.0	-8.3	5.0	46.3
15. Texcoco, Mexico	2250	768.8		15.7	34.0	-6.0	6.6	40.0
16. Tizayuca, Hgo.	2270	600.5		15.5	35.0	-7.5	7.6	42.5
17. Tlalmanalco, Mexico	2400	984.0						
18. Tlalnepantla, Mexico	2250	680.3		15.0	33.0	-8.5	6.1	41.5
19. Tlalpam, D. F.	2240	863.8						
20. Villa Obregon, D. F.	2300	733.2		14.9	33.0	-5.0		38.0
21. Xochimilco, D. F.	2240	739.8		15.7				

Table 1

Summary of Meteorological Data

for the Various Stations in the Basin of Mexico

Notes: Precipitation and evaporation in mm
Temperature in °C
The number of each station corresponds to the number on Map 2

No. of years covered	8	9	10	7	7	6	7	7	7	8	9	9
Average Monthly Evaporation	127.06	141.94	180.95	195.73	183.85	146.23	132.40	133.63	111.11	125.56	111.84	110.55
No. of years covered	21	23	23	23	22	22	22	21	22	21	21	22
Times Frost Occurred	21	19	15	7	1				1	9	16	20
Minimum Temperature Registered	-11.5	- 9.2	- 5.2	- 4.7	- 1.0	3.2	0.8	2.9	- 1.0	- 7.5	- 7.0	- 8.9
Maximum Temperature Registered	28.9	29.8	32.9	32.7	34.5	30.3	28.1	29.0	27.3	29.2	28.1	28.6
Average Monthly Temperature	11.81	13.39	14.72	16.91	17.47	17.26	16.18	16.06	15.66	14.36	12.92	11.63
No. of years covered	18	20	20	20	19	16	18	17	18	15	17	19
Times Rainfall below Average	16	14	13	12	12	10	8	5	8	9	11	14
Times no Rainfall	9	12	6	1	1						4	10
Minimum Monthly Rainfall	0	0	0	0	0	43.7	43.5	31.1	29.7	1.0	0	0
Maximum Monthly Rainfall	56.0	24.2	33.9	82.6	130.2	185.0	194.1	160.2	176.6	92.5	45.0	40.6
Average Monthly Rainfall	8.4	3.37	9.45	25.61	62.13	99.21	107.67	95.60	100.01	40.03	12.82	4.80

Max. An. Prec 764.5
Av. An. Prec. 581.69
Min. An. Prec 381.7

J F M A M J J A S O N D

Table 2 - Summary of Meteorological Data for Chapingo (1941-1963)

NOTE: Precipitation an evaporation in mm
Temperature in °C

Max. An. Prec. 791.5	J	6.3	34.9	0	11	15	24	12.46	29.5	-8.3	20	157.45	23
Ave. An Prec. 547.54	F	5.1	29.0	0	12	16	24	13.41	29.0	-6.0	20	180.30	22
Min. An. Prec. 378.75	M	10.97	59.0	0	10	14	24	15.50	31.5	-2.3	5	233.37	21
	A	34.89	85.7	0	1	11	23	16.99	34.0	-2.5	3	235.75	22
	M	64.64	164.7	16.8		12	23	17.38	33.5	1.3		220.10	22
	J	92.92	222.5	21.0		15	23	17.10	38.0	1.8		185.23	20
	J	87.87	154.0	25.7		11	24	16.32	30.5	3.3		165.30	19
	A	98.96	151.5	13.0		11	24	16.23	29.0	3.0		164.45	19
	S	75.47	170.5	31.0		15	23	16.01	28.8	0.5		144.59	20
	O	37.87	110.3	0	2	14	23	14.70	28.5	-4.5	5	159.91	20
	N	17.05	66.2	0	5	14	23	13.75	28.5	-4.0	14	151.29	22
	D	4.48	21.5	0	10	15	24	12.44	29.5	-5.3	20	142.18	22
		Average Monthly Rainfall	Maximum Monthly Rainfall	Minimum Monthly Rainfall	Times no Rainfall	Times Rainfall below Average	No. of years covered	Average Monthly Temperature	Maximum Temperature Registered	Minimum Temperature Registered	Times Frost Occurred	Average Monthly Evaporation	No. of years covered

Table 3 - Summary of Meteorological Data for Teotihuacan (1938-1963)

NOTE: Precipitation and evaporation in mm
Temperature in °C

TABLE 4

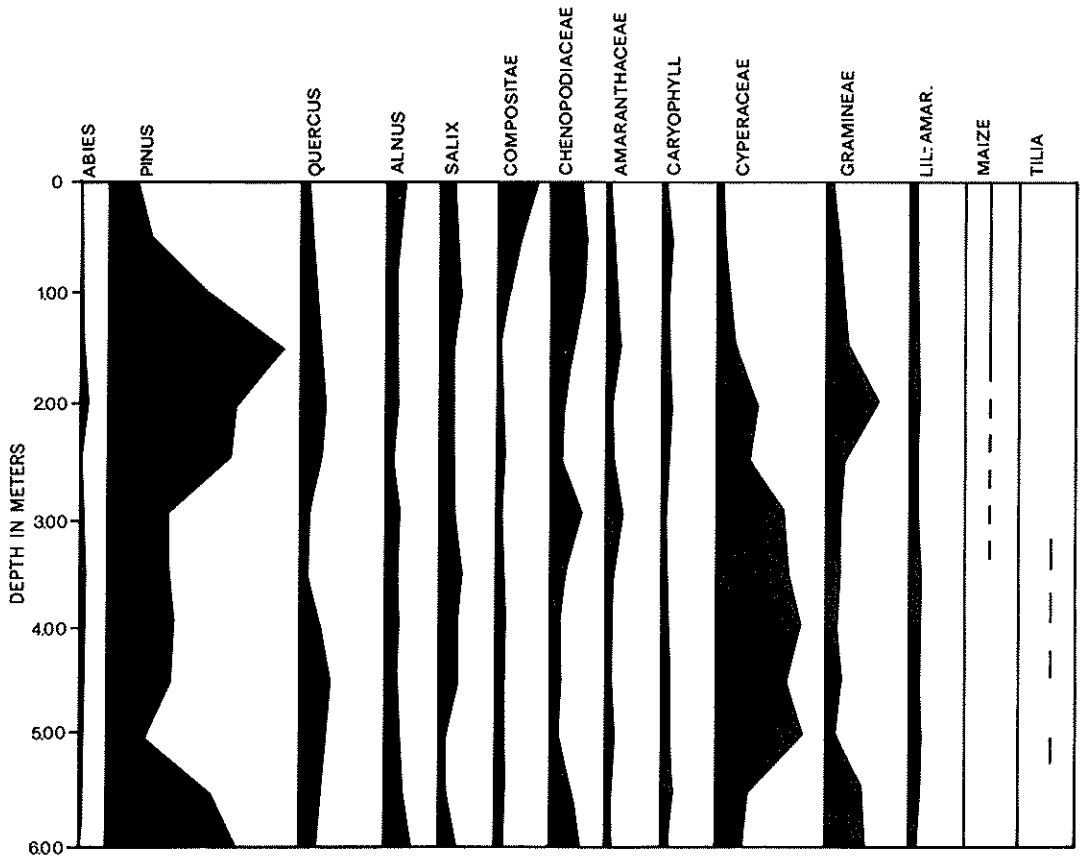
ANNUAL PRECIPITATION IN TACUBAYA, D. F. (1878-1950).

Year	Annual Precipitation	Year	Annual Precipitation	Year	Annual Precipitation
1878	894.6 mm	1902	451.4	1926	594.9 mm
1879	477.2	1903	574.9	1927	587.1
1880	554.2	1904	803.7	1928	615.4
1881	595.4	1905	419.4	1929	.....*
1882	661.0	1906	614.1	1930	639.7
1883	608.7	1907	599.6	1931	743.9
1884	468.5	1908	645.2	1932	.....*
1885	675.7	1909	344.5	1933	499.3
1886	531.2	1910	561.2	1934	524.3
1887	812.7	1911	676.1	1935	588.6
1888	739.9	1912	597.3	1936	540.7
1889	498.1	1913	607.0	1937	748.9
1890	638.1	1914	759.1	1938	560.7
1891	658.3	1915	571.0	1939	471.9
1892	444.2	1916	508.6	1940	.....*
1893	568.6	1917	408.9	1941	.....*
1894	331.8	1918	580.0	1942	.....*
1895	559.1	1919	699.3	1943	.....*
1896	452.0	1920	563.4	1944	542.1
1897	652.1	1921	537.1	1945	341.3
1898	593.6	1922	725.1	1946	454.9
1899	581.1	1923	479.4	1947	.....*
1900	535.9	1924	.....*	1948	609.5
1901	527.1	1925	.....*	1949	.....*
				1950	.....*

* Data incomplete for the year

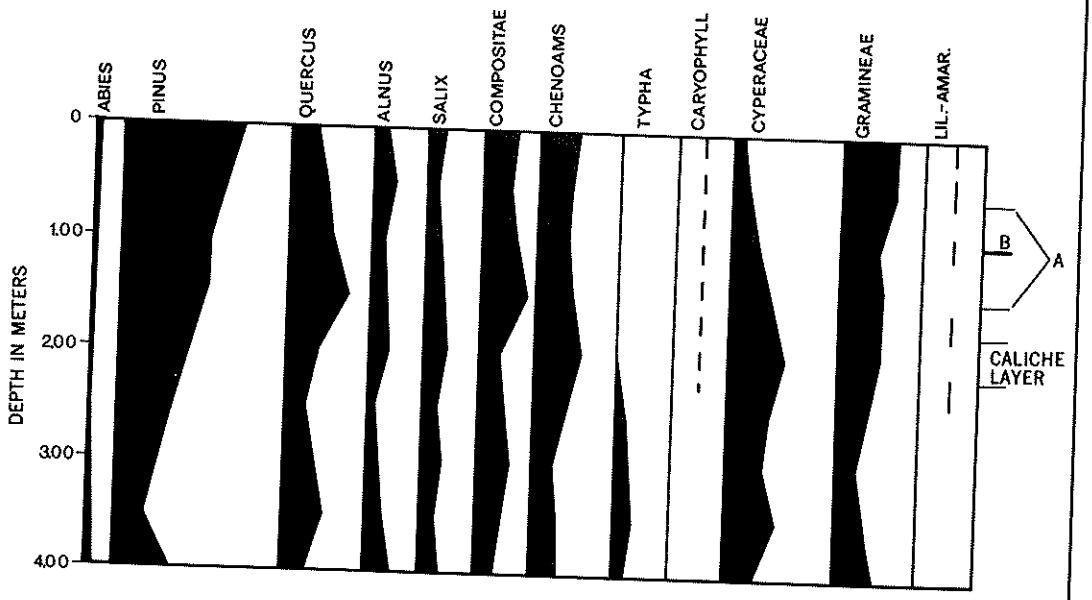
POLLEN DIAGRAM 1

EL TULAR



POLLEN DIAGRAM 2

CUANALAN



A = CUANALAN PHASE OCCUPATION

B = FLOOR

THE GEOGRAPHY OF THE VALLEY OF TEOTIHUACAN

by

William T. Sanders

TABLE OF CONTENTS

Basin of Mexico 71
Teotihuacan Valley 74
Topography and Hydrography 74
Climate 75
Soils 76
Specialized Resources 77
Ecological Divisions of the Valley 78
Geographical History 79
Bibliography 85

LIST OF ILLUSTRATIONS

Figure 1 - Ecological Map of Teotihuacan Valley 87
Figure 2 - Graph Correlating Lake levels, (Lake Texcoco) Precipitation and Archeological Periods 88
Plate 1 - Aerial Photograph - Teotihuacan Valley 89
Plate 2 - Aerial Photograph - The Delta 91
Plate 3 - Aerial Photograph - The Lower Valley 93
Plate 4 - Aerial Photograph - The Middle Valley 95
Plate 5 - Aerial Photograph - The Upper Valley 97
Plate 6 - Aerial Photograph - Cerro Gordo - North Slope and North Tributary Valleys 99
Plate 7 - Aerial Photograph - Patlachique Range 101

THE BASIN OF MEXICO

The Basin of Mexico is a great elevated plain surrounded on three sides (to the east by the Sierra Nevada, west by the Sierra Las Cruces, south by the Sierra Ajusco) by high mountain walls and to the north by a series of low, discontinuous ranges of hills. The mountain wall reaches a maximum elevation of slightly below 6000 m. in the south-east with two snow-capped volcanoes, Ixtaccihuatl and Popocatepetl. The three ranges have numerous peaks with elevations in the 3000-4000 m. band and the Basin floor in the center has an elevation of approximately 2236 m. above sea level.

Before the construction of the "Gran Canal", the Basin was a closed hydrographic unit. Melt water from snowfields, springs, and runoff from the summer rains all flowed into the center of the Basin, draining into a chain of lakes that nearly traversed it from north to south. The colonial documents refer sometimes to three, at times as many as six, lakes (based on such artificial divisions as dikes); but during part of the year they formed a single sheet of water, located at varying elevations. To the north was Lake Xaltocan (or Lakes Xaltocan-Zumpango); the center, Lake Texcoco (or Lakes Mexico-Texcoco); and to the south, Lake Xochimilco (or Lakes Chalco-Xochimilco).

Lake Chalco-Xochimilco was located three meters higher than Mexico-Texcoco and drained into it. Because of this outlet, which apparently functioned all year, and the presence of numerous springs along the southern shore, the water was fresh and covered by floating vegetation ("so thick one could walk on it"). Lake Mexico-Texcoco was the lowest lake, was extremely saline, and the ultimate destination of all drainage. Lake Xaltocan-Zumpango was also situated at a higher level than Lake Texcoco-Mexico but drained into it only seasonally and was therefore more saline than Chalco-Xochimilco, except for small areas near local springs.

In the nineteenth century the lakes covered an average area of approximately 1000km^2 or one-eighth of the surface of the Basin. The average contour of the shore of Lake Texcoco was 2240 m., although this varied from season to season and year to year. The lakes were shallow, varying from one to three meters in depth. During dry seasons they frequently shrank in surface area so that canoe traffic from lake to lake was interrupted for short periods.

The total surface area of the Basin of Mexico is approximately 8000 $km.^2$ and it extends approximately 120 km. N-S by 70 km. E-W.

Melt water from the snowfields, local springs (especially in the south) and runoff from the rains feed into hundreds of permanent and seasonal streams that ultimately enter the lake system. The seasonal streams have cut canyon-like beds, locally called barrancas, and the drainage from rainfall is extraordinarily vigorous and destructive.

Within the Basin, rainfall is sharply seasonal and is concentrated in the months from June through September. Rains usually begin in May and

decrease sharply in October. Approximately five-sixths of the rainfall occurs between May 1 - October 1. Inception and closure of the rainy season varies considerably from area to area and year to year, as does the annual rainfall. Internal droughts are common in the north and central parts of the Basin during the rainy season. No recent cases are known, however, of complete failure of the rainy season as a whole. Rains also tend to occur in late afternoon and evening. Hail storms are also common during the rainy season but a snowfall would be an extraordinary event. Mean annual rainfall varies from south to north and from basin floor to adjacent slopes. Stations in the northern Basin range from 500-600 mm., in the center from 650-750 mm. and in the south averages as high as 1100 mm. are recorded, all for the Basin floor. Rainfall for adjacent slopes, particularly on the middle flanks of the major ranges, is markedly heavier than that on the nearby plain, but there is little data for these areas. Averages of around 1400 mm. have been recorded for the slopes in the southeast.

Considering only mean annual rainfall, the southern part of the Basin would seem to be the most favorable part for maize cultivation without irrigation. In the central and northern parts of the Basin, even where soils are deep and loamy in texture, maize cultivation without irrigation is possible but crop security is low and production varies considerably from year to year. Yields are generally improved considerably (in many areas doubled) by irrigation, and it is absolutely necessary for effective maize agriculture all over this area where soils are one meter deep or less. The high elevation with correspondingly higher rates of transevaporation further aggravates the problem.

The modern peasant population of the Basin resides within a contour strip ranging from 2240-2800 m. above sea level. There is no permanent population of subsistence farmers above the latter elevation. Even those communities that lie between 2600-2800 m. have an economy based partly on grazing and lumbering. The primary factor that limits the upward expansion of agriculture seems to be the temperature regime. At lower elevations frosts begin normally in October and last until the beginning of March. Maize, the staple crop, (and nearly all of the secondary pre-Hispanic cultivates) cannot be grown during this frost season. Maize is expecially susceptible to frost damage, notably during the early phase of its growth. The range of inception and cessation dates of the frost season varies as much as the rains do. In occasional years frosts begin as early as September or as late as December and may last through March and even April. Below 2600 m., however, local elevations seem to offer more favorable conditions for agriculture than the plains proper, since frosts tend to settle in the lower areas. Above 2800 m. the normal frost-free season is too short for dependable maize cropping. Particularly disastrous for agriculture based only on rainfall is a combination of a late inception of the rainy season and an early frost season, since crop planting must be delayed. Under such conditions plant growth is retarded so that the early frosts cause heavy damage. Of course, too early a planting is risky as well.

Most soil maps classify soils of the central and southern parts of the Basin (within the strip of agricultural exploitation) as "Chernozems", those of the north as "Chesnut". Both are associated with subhumid to semi-arid climates, fit into a major soil grouping called "soils of calcification" and generally have great natural fertility. The overall impression is that local differences in soil types within the 2240-2800 m. contours are minor in relation to agricultural productivity. Much more important are variations in soil depth and texture, because these soil characteristics are those most closely related to the problem of water conservation.

Soil depth, because of variations in intensity of erosion or angle of slope, varies considerably and has a striking effect on agriculture production, particularly in the drier center and north. The least productive part of the Basin is undoubtedly the north where mean annual rainfall is lowest. Maize cultivation is exceedingly precarious in that area. With respect to soil texture, loamy, friable, loose-textured soils are the most common and are ideal for primitive agriculture. They are, however, extremely susceptible to erosion. Sandy and clay-textured soils do occur in localized areas; the former in eroded slopes where the finer soil particles have been washed out, the latter especially near the lake shore and along streams. Above 2600-2800 m. podzol soils predominate. They are notoriously poor soils for agriculture, a further factor limiting its upward expansion.

It is difficult to reconstruct the natural vegetation of the Basin (see Kovar, page 21 in this volume) since at least 4000 years of agricultural exploitation has completely removed it from the zone of peasant occupation. With respect to human occupation and land use, two important points may be stressed. Between 2240-2600 m. the permanent removal of the vegetation (in contrast to the tropical lowlands of Mesoamerica) presents no serious obstacle to the Mesoamerican farmer even with his primitive technology. Above 2600-2800 m. the pre-Hispanic population had an easily available source of forest products for construction, household technology, transportation and medicine.

In summary, this brief survey of the geography of the Basin of Mexico reveals a number of significant factors with respect to its utilization by a farming population equipped with a technological complex comprised of neolithic tools, simple transportation and a cereal (maize) as a staple food:

1. The soils are easily cultivated using neolithic tools, are generally fertile and capable of sustained cultivation with modest application of simple soil restoration techniques (i.e., animal and vegetable fertilizers, crop rotation, short-phase fallowing, intercropping, floodwater and permanent irrigation, terracing). There is, however, a high percentage of sloping terrain where soils are markedly susceptible to erosion, and constant effort is required to control this destructive process.

2. The plant cover is fragile and easily controlled with simple tools.

3. The rainfall-temperature regime is favorable to maize cultivation only in the south. In the central and northern parts of the Basin the combination of early frosts and retarded rains, plus internal droughts, make maize cropping difficult and crop loss frequent.

4. In a number of areas local, permanent, water resources are available for permanent irrigation, and the numerous barrancas are sources of water for floodwater irrigation. Such systems, however, require intensive land use, heavy expenditure of labor per man, and supra-family, often supra-community, cooperation to maintain, construct and operate.

5. Since the summer rains generally provide adequate moisture in areas with moderately deep to deep soils, the primary need is a pre-planting irrigation. This enables the farmer to get a head start on the rainy season and gives the plant more time for growth before the arrival of the fall frosts. Most of the humidity for plant growth, even in areas of permanent irrigation, is derived from rainfall. This means that a small amount of irrigation water goes a long way, as will be demonstrated in the case of the Teotihuacan Valley. Mexican agronomers call this system "medio riego".

6. The lakes were an enormously significant resource for the pre-Hispanic and Colonial population. They provided a natural highway system for a people lacking beasts of burden. They linked all parts of the Basin, and most of the major population centers in 1519 were located near the shore or within the lakes. The lakes were important sources of protein foods for a population with few domestic animals, and of other products, especially salt. The freshwater Lake Chalco-Xochimilco was nearly covered by artificial, island-like gardens called chinampas, which were the most intensively cultivated and productive lands in Mesoamerica and provided much of the surplus foods for the support of urban communities in 1519.

7. Internally there is considerable variability in geographical characteristics within the Basin, a characteristic that stimulated local specialization and trade. Variations in amount and distribution of rainfall, vegetation, topography, soil depth, water resources, elevation, and spatial position with respect to mountain passes and lake shores, along with the distribution of specialized resources (salt, clay, obsidian, lumber, lime, stone, etc.), all acted as factors promoting this specialization and trade.

Ranges of small hills within the Basin tend to isolate parts of it into smaller topographic and hydrographic units. One of these is the Teotihuacan Valley, the subject of this paper. A detailed analysis of the geographic characteristics of this unit follows.

THE TEOTIHUACAN VALLEY

Topography and Hydrography. The Teotihuacan Valley is defined in this report as the drainage basin of the Rio de San Juan and covers an area of 600 km.^{2}. From Ixtapan, on the shore of Lake Texcoco, to Xaltepec, near the northeastern watershed, the Valley has a total length of 35 km. The elevation of the Valley floor varies from 2240-2300 m. and slopes gently down from northeast to southwest.

The southern and southeastern edges of the Valley are bordered by a solid rampart of hills with tributary valleys and small intermontane plateaus called the Sierra de Patlachique with a maximum elevation of 2800 m. It is a spur of the big Sierra Nevada range. To the north, the Valley is

delimited by a string of isolated volcanoes separated by wide passes; major peaks here are Cerro Chiconautla (2630 m.), Cerro Malinalco (2580 m.) and Cerro Gordo (3050 m.). To the northeast, the Valley is open to the Tepeapulco-Apan plain with a low ridge serving as a watershed.

The Valley as defined above is a hydrographic unit. Drainage is explosive and destructive, and all slopes have deep gullies or barrancas that carry runoff to the mainstream, El Rio de San Juan, which in turn empties into Lake Texcoco. The flow of water in all of the barrancas is sharply seasonal and even during the rainy season water usually flows only a few hours, or at most a few days, following the torrential showers. The Barranca de Los Muertos, Atlamajac o Ixtetes, Huixcololco, San Martin and San Lorenzo (see Figure 1) are especially significant in agriculture, particularly the first two. All of the mentioned streams join the Rio de San Juan above the town of San Juan Teotihuacan.

Approximately 80 permanent springs are located in a small area within and just outside of San Juan. They provide a relatively constant (varying seasonally) flow that averages approximately 600 liters of water per second into the river system, so that below the town, the Rio de San Juan becomes a permanent stream. There is an area of about 100 hectares in the vicinity of the springs where the water table is less than one meter below the surface.

Climate. Page 64 (compiled by Anton Kovar) summarizes the temperature and rainfall data at the one, permanent, meteorological station in the Valley (at the archaeological zone) for the period 1938-1963. Precipitation and evaporation figures are in millimeters, temperature is in the centigrade scale.

Generally speaking, the chart indicates a pattern fairly typical of the Basin of Mexico as a whole but with certain local peculiarities.

The low ranges that define the Valley act as an obstacle to free movement of moisture-laden winds and reduce the annual rainfall to one of the lowest averages in the Basin of Mexico. At least four-fifths of the total rainfall falls in the period from June 1 - October 1. An inadequate precipitation for a May planting is more common an occurrence than in most stations in the Basin. The pattern of rainfall noted as characteristic of the Basin as a whole, with brief, torrential, highly localized showers; late inception; and internal droughts are nowhere as pronounced as in the Teotihuacan Valley. The extraordinary range of rainfall from year to year (almost 100 percent) and high frequency of years with below average rainfall both point out the difficulties for maize cultivation without supplementary irrigation.

Our impressions indicate that rainfall is somewhat higher, possibly by as much as 50 percent, on the upper slopes of the Patlachique Range and Cerro Gordo, with perhaps less of an increase on Chiconauhtla and Malinalco. This observation is based on the relative lushness of natural vegetation, since meteorological stations are absent. Camphor forests and unusually good pastures are on top of Cerro Gordo.

The greater tendency for the rains to come late and for a generally lower rainfall than in most of the Basin retards planting, slows down plant growth, and aggravates the early frost problem. As can be noted in the "times frost occurred" column, temperatures below freezing may occur during the period from October 1 to May 1. Normally, the frost season runs from November 1 to March 1. This latter fact is extremely significant in terms of patterns of land use.

In the Teotihuacan Valley perhaps more than in any other part of the Basin, the timing of rainfall and frosts is of utmost concern to the peasant farmer; some crop loss is a common occurrence and crop disasters not infrequent. During the five years of the project, 1960 and 1961 were fair years with perhaps half of the unirrigated crops producing from fair to good yields; 1962 was a disaster year with the unirrigated crops a complete loss and even irrigated crops producing only from one-half to three-quarters of normal years; 1963 was a good year in which only maize crops planted on shallow soil failed to produce; 1964 was a poor year, almost as bad as 1962.

One of the impressions of the author, based on the five-year period, is that some kind of a positive correlation exists between dry rainy seasons and early frosts and between wet rainy seasons and a late inception of frosts. If the correlation holds as a general rule, it may be of crucial importance in the study of cycles of climatic history of the Valley and land use patterns.

Soils. The subsoil of the Teotihuacan Valley consists of a material locally called "tepetate", a hard, compact, crumbly, earth-like formation that is relatively impervious to water in contrast to the soil above. According to Gamio's field study, it is composed of volcanic ash and redeposited by fluvial action.

The organic or "A" soil layer above the tepetate varies considerably in thickness over the Valley and is generally loamy in texture. Near the barrancas and lake shore, clay textured soils are common and in badly eroded areas sandy textured soils predominate. In general, soils in the plains are deeper and more finely textured than those on slopes; soils in the Lower Valley are deeper and finer textured than those in the Upper Valley. Most of the soil in the Valley is easily worked with simple tools and has extraordinary capacity for storing water. In areas where soil depths exceed one meter, water may be stored for several months using special techniques of working the soil. The less permeable layer of tepetate below acts as an artificial tank floor.

Soils are generally classified as "Chesnut" in most of the Valley and Chernozem in the alluvial plain of the Lower Valley and Delta. Such soils, before degraded by intensive cultivation, are characterized by fair to rich concentrations of organic matter, nitrogen and lime, and have a high concentration of potassium and phosphorous. Furthermore, in arid climates like that of the Teotihuacan Valley, there is a general tendency for water to percolate upward in the soil bringing fresh supplies of plant nutrients to the surface. Today, with varying degrees of intensity of cultivation and application of soil restoration techniques, the soil varies considerably in the presence of these nutrients and greatly degraded soils

are common. In general, soils of the Teotihuacan Valley are fertile, capable of sustained cultivation, and rarely fallowed. The major soil factor that inhibits or limits productivity is depth. In the alluvial plain, soil depth varies from three-tenths to three meters in the Upper and Middle Valleys and increases to seven to eight meters near the lake shore. Most of the slopes, however, have a soil depth of less than 50 cm. and large areas of exposed tepetate are common.

Specialized Resources. The Teotihuacan Valley, as in the case of the larger unit (the Basin of Mexico), is characterized by definite ecological zoning and localized distribution of key resources. Lake Texcoco at the lower end of the Valley was an important source of salt, and several villages, Ixtapan, Nexquipaya and Tequisistlan specialized in salt-making in the sixteenth century and still do so today. Although not as rich in aquatic life as the freshwater lakes, Lake Texcoco also provided some resources such as fish, reeds for mats and baskets, insect larvae and eggs. Even today, although the lake has almost disappeared, the lake shore villages purchase excess water from the irrigation system, divert it into big earth banked tanks in the lake bed and raise fish! Clay deposits for pottery and clayey textured soils for adobe are found all over the Valley but are especially extensive in the lake shore plain and along the margins of barrancas. Several villages specialize in pottery and adobe manufacture. Obsidian resources are concentrated in the Upper Valley in the hilly borders and barranca profiles above Otumba. In the pre-Hispanic, Colonial and Republican Periods deposits of volcanic material varying in size from fine gravel to rock outcrops have provided material for building construction and are especially abundant in the Middle Valley.

Ecological Divisions of the Valley. On the basis of the discussed geographical variations, the Teotihuacan Valley may be divided into the following ecological zones. These divisions played highly distinctive and varied roles in the history of occupation in the Valley.

1. Upper Valley - from San Pedro Ixquitlan to Xaltepec. The town of Otumba is located in the center of this division of the Valley within a small oval depression of deep soil. The soil ranges from 50-200 cm. in

depth and the depression has a diameter of two to three kilometers. Surrounding this core of deeper soil to the north, east and south is a band of gently sloping piedmont with thin soil, approximately 10 km. in width. To the north and northeast this piedmont is delineated by a few low hills, to the south and southeast by foothills of the northern terminus of the Sierra Nevada or by the Patlachique Ranges. The Upper Valley is the most unfavorable area for agricultural exploitation today. Barranca runoff is abundant only to the south and even there the hills are so far from the deep soil core and so deeply eroded that very little floodwater irrigation is possible. Nearly all cultivation is "temporal" (i.e., based on rains) and it is primarily a zone of maguey cultivation. There are small, deep soil flood plains along the barrancas to the south that alleviate the problem somewhat, but the total acreage is small. A special local resource other than agriculture in this area for the pre-Hispanic Period would be obsidian.

2. Middle Valley - the section of the Valley between San Juan Teotihuacan and San Pablo Ixquitlan. The topographic and hydrographic characteristics of this section of the Valley are exceedingly complex with numerous barrancas, each with small flood plains separated by low ridges and hills. The largest of these flood plains extends from San Juan Teotihuacan to San Pablo Ixquitlan in the center of the Valley where soils vary from one to three meters in depth. Soil depth on the piedmont of Cerros Gordo and Malinalco and the Patlachique Range or on low ridges and hills is much less.

The key factor affecting agriculture in this area is the combination of extensive, deep soil plains within a short distance of adjacent hills, and numerous barrancas with shallow enough beds to serve as sources of water for floodwater irrigation. Special resources located in the area are good pottery clay and abundant volcanic debris for building materials.

3. Lower Valley - the section from San Juan Teotihuacan to Cuanalan--including the prize agricultural land of the Valley. In the center is a great continuous alluvial plain varying from four to five kilometers in width, with a soil cover varying from three to seven meters in depth, a total area of approximately 3000 hectares. The San Juan springs are located just above the plain, providing a permanent source of water for irrigation.

Between Cuanalan and Tepexpan the alluvial plain constricts to a width of only 1500 m. and then fans out into the lake shore plain or Delta which in turn merges into the large Texcoco plain to the south.

Adjacent and parallel to the alluvial plain on each side is a narrow, gently sloping piedmont varying in width from 500-1000 m. on the east side to a band twice as wide on the west. In these two strips soil depth is extremely variable but generally has a modal depth of 20-60 cm. with much exposed tepetate. Soils are deeper where barrancas and their small flood plains traverse the piedmont. The steep, nearly denuded slopes of the Patlachique Range border the piedmont on the east side of the Valley, whereas the gentler slopes of Cerro Chiconauhtla and the Maravillas cluster of small hills to the west and north are terraced nearly to their summits.

4. Delta - a fan-shaped plain along the lake shore. Ecologically the area differs from the Lower Valley in that it is further from the springs and the supply of water (especially in drier years) for irrigation is more limited. It is also further from the hilly flanks thus reducing available runoff for floodwater irrigation. Finally, the presence of the lake offered to a peasant population a variety of resources not found elsewhere in the Valley (salt, fish, more extensive clay deposits).

5. Patlachique Range - defined as a distinct ecological division for a number of reasons. Rainfall is undoubtedly higher than in the adjacent valley floor, slopes are steeper, and soil cover much less than most of the Valley. It is also the largest continuous mass of high ground and therefore relatively frost-free. Along with steep slopes, however, small intermontane plateaus, valleys and gently sloping surfaces have greater agricultural potential in terms of present-day erosion patterns.

Before intensive cultivation, there was undoubtedly a fairly deep soil cover, even on the steeper slopes. At one time we suspect that the area had considerable vegetation and that many of the deep barrancas were probably small permanent streams. These characteristics plus the higher rainfall and relative freedom from frosts would have given the area unique advantages for primitive agriculture within the Teotihuacan Valley. Today, because of extensive erosion, it is primarily used for pasture.

6. North Tributary Valleys - as has been noted, the hills that border the Teotihuacan Valley to the north are separated by wide passes. A network of barrancas draining into the San Juan River, in the Middle and Lower Valley, originates north of the hills and enters the Valley by way of these passes. The area is characterized by small flood plains bordering the barrancas and badly eroded, gentle slopes. In part its northern edge is defined by a cluster of small hills where erosion is less severe.

7. Cerro Gordo-North Slope - the north slope of Cerro Gordo, strictly speaking, is not part of the Teotihuacan Valley since the drainage flows northwest directly to Lake Texcoco. It was included in the survey because of the presence of an extraordinarily heavy Teotihuacan occupation (Tzacualli through Xolalpan). It is an area of long descending ridges separated by barrancas with abundant runoff. Today it is elaborately terraced into one of the most complex terrace systems in the survey area. The addition of this area plus that part of the North Tributary Valleys that does not drain into the Teotihuacan Valley increases the size of the project survey area to an approximate total of 650 km.^{2} (600 included in the Teotihuacan hydrographic basin).

Geographical History. The descriptions of the natural environment of the Basin of Mexico provided by the relaciones of the sixteenth century demonstrate that there were no major differences between the environment then and the twentieth century, other than those created by Man himself. The lakes have all but disappeared as the result of artificial drainage projects and erosion has destroyed much of the soil on slopes. There is convincing evidence that much of the sheet erosion seen on the lower slopes and piedmont of the Valley is the result of processes that post-date the Spanish Conquest and that such lands were covered by carefully maintained terrace systems in Aztec times. The drastic population decline

that followed the Conquest resulted in the abandonment of much of the terraced lands and their conversion to pasturage for goats or sheep. As a result, the terraces were eroded away and much of the Valley converted to the desolate tepetate wasteland so characteristic of much of the Central Plateau today.

Post-hispanic erosion also resulted in a widening and deepening of the barrancas but the basic hydrographic system has changed very little since the sixteenth century. Streams that are seasonal now are described as seasonal in the relaciones. The relaciones also emphasize the scarcity of water and many villages relied on jagueys for most of their water supply. Aztec history is replete with references to droughts and frosts so that the two major problems faced by modern cultivators were problems then. In summary the Aztecs of the fifteenth and sixteenth centuries faced the same problems of adaptation to environment as do modern mestizo peasants and as shall be demonstrated in a later report the responses were similar.

Since a major objective of the project was to collect data on the history of agriculture and to correlate the development of agriculture with the growth of cities and states, a knowledge of the pre-Aztec geographical history of the Teotihuacan Valley is crucial. Many of our conclusions about pre-Aztec agriculture are based on indirect archaeological evidence and inferential reasoning derived from a comparison with Aztec and post-Conquest patterns. The use of such evidence assumes that the geographic characteristics of the Valley have not changed in any major way over the past 4000 years.

The most important single factor affecting settlement in the area is water. In the Teotihuacan Valley water is obtained from two sources, precipitation and subterranean; the latter ultimately derives from the former. Changes in rainfall and variations in flow of water from the springs would be critical factors effecting land use and agricultural techniques.

In a recent publication Lorenzo (1956) has summarized the evidence for climatic change in the Basin of Mexico. In this report he cites two lines of evidence, fluctuations in lake levels and pollen profiles. He concludes that there were some changes in lake levels between the beginning of the Formative Period and 1519. We have adapted his graph of lake levels in Figure 2. The graph is based on the following data:

1. Evidence of periodic flooding at Zacatenco, El Arbolillo and Ticoman from Vaillant's excavations indicating higher (than Aztec) lake levels during the Middle Formative.

2. Evidence at Tlapacoyan of a drop in lake level between Middle and Late Formative times.

3. The Terminal Formative site at Chimalhuacan is located on the 2237 m. contour, five meters below the Aztec shoreline. The site in question is definitely a village site, not a set of chinampas. It consists of scores of rock mounds arranged in a linear strip. The linear pattern is typical of Aztec settlement and in all known cases relates to topographical features, in this case undoubtedly a lake shore.

4. Aveleyra excavated a tlatel near the Tepexpan Man site in the Teotihuacan Valley (our TC 3 site). His excavation revealed a predominantly Teotihuacan Period occupation. Since the tlatel is at the 2242 m. contour, Lorenzo argues that the Early Classic lake was as large as the Aztec. We agree, but in his report he does not demonstrate that the site had any necessary relationship with a lake shore. Our examination of the site plus a new excavation by Litvak King (1964) suggests the strong probability that it is a salt-making site. Such sites always occur in the immediate vicinity of the lake shore.

5. Evidence for the postulated lowering of lake level in the Toltec Period is not presented.

The Teotihuacan Valley Project data, insofar as it can be related to the problem supports Lorenzo's reconstruction. Several Aztec salt-making sites were located, all on the same contour and in the vicinity of the Aztec beach. Two of these sites (not including TC 3) had traces of Teotihuacan and Mazapan occupation. The most convincing support of Lorenzo's reconstruction, however, comes from a site near Venta de Carpio on the old Aztec shoreline (TF 73). Two trenches were excavated and the site was surface sampled. Three major phases of occupation are represented, Chiconautla, Tlamimilolpa and Aztec. There is a light Cuanalan occupation, no Terminal Formative and scanty Mazapan.

The phase of heaviest use of the site includes occupational debris in situ, in other words it was a living site during those phases. No evidence of salt-making was found which means that one cannot definitely assume that the occupation phases relate to lake levels. The close correlation of phases of maximum occupation with Lorenzo's phases of high lake level, and the lack of substantial occupational during lower and higher levels, however is very suggestive of such a relationship.

In conclusion, it seems probable that minor fluctuations in lake level have occurred between the beginning of the Formative and 1519. The major problem is whether the changes in lake level were the products of fluctuations in precipitation or some other process. One factor that might affect lake levels is erosion of hillsides followed by sedimentation in the lake bed. Lorenzo seems to suggest this as the factor. He argues that slash and burn agriculture was characteristic of both the Formative and Classic Periods and that intensive agriculture began in post-Classic times. This he feels resulted in severe erosion. Kovar (see this volume) sees much of the fluctuation of the lake level as the product of sedimentation (both natural and as the product of human activities) into the lake bed. He also suggests that the deforestation of the slopes through agriculture released additional water for the lakes that had once been used up by the process of transpiration.

The second line of evidence cited for climatic history derives from palynology or fossil pollen analysis. Sears in 1951 published the results of his pollen studies from cores taken from the old lake bed. In this report he suggested that there were changes in rainfall during the period in question and attempted to correlate them with archaeological periods. He argues that the Formative Period was characterized by higher lake levels and higher precipitation than in 1519, that the Classic was a period of lower lake levels and drier climate, and that in post-Classic times there was a return to a higher lake level and precipitation (but not high as in the Formative Period). This reconstruction was based on a percentile comparison of tree versus herbaceous plant pollen. This reconstruction does not agree with

the evidence previously presented and was severely criticized by Lorenzo. Lorenzo argued that the decline of tree pollen was simply the product of human activities in the Basin and related to population growth. We agree that much of the decline of forest pollen was indeed the product of agricultural activity but again how does this explain the cycling of lake levels in the graph?

As part of the Teotihuacan Valley Project activities, Kovar took several pollen cores from localities in the Teotihuacan Valley. One of the most significant cores was taken from El Tular, a small spring near Atlatongo. The results are presented in the graph in page 66 , Kovar, this volume.

Summarizing briefly, the principal characterisitcs of the graph are:

1. One of the dominant vegetation types was apparently cyperacaea, water loving plants commonly called sedges. They make up approximately 30 percent of the sample in the lower levels, and were probably the dominant plants all over the spring area before it was drained for irrigation.

2. Between the 1.5 m. level and the uppermost sample there was a very rapid decline of tree pollen coincident with an increase of compositae and chenopodium, plants that thrive as weeds on agricultural land. This pollen is undoubtedly the product of deforestation by man as Lorenzo suggests.

3. The behavior of pinus (Pine) and quercus (oak), however, may suggest minor climatic changes. Even eliminating local vegetation like the cyperaceae from the graph, there are still two definite peaks in the frequency of these types.

4. A major problem is the correlation of the Tular graph with the archaeological sequence. A core taken from near the excavation site at Cuanalan provides the key to this correlation. The pattern of events at Cuanalan is in very close agreement with that from Tular excepting, of course, a much lower percentage of cyperacaea since there were no springs around Cuanalan. The pollen levels at Cuanalan can be related to the Cuanalan Phase (Late Ticoman) occupation there and demonstrate that the drainage at El Tular took place at the close of the Late Formative Phase. This indicates that the two peaks at Tular of tree pollen coincide with the Early Formative and Early Classic archaeological periods.

5. The decline of pine following the first peak seems to occur somewhat earlier than the decline of oak. In terms of the reconstruction of agricultural history, this makes sense. We have evidence of a focus of occupation in the hilly flanks during the Formative. Pine tends to replace oak upslope in the Basin of Mexico as a whole. The earlier decline of pine therefore is probably the product of this selective deforestation of slopes for agriculture.

McQuown (1961) reports a parallel situation that occurred in highland Chiapas in pre-Hispanic times. Slash and burn agriculture in that area also selected against pine and for oak so that the former suffered most from agricultural activities. In our graph the evolution of intensive agriculture in the final phases resulted ultimately in a complete destruction of both the pine and oak forests.

With respect to the interpretation of the history of lake levels and vegetation, both Kovar and myself are in fundamental agreement then that much of it is the product of human activities. The reduction of forest was in large part the product of agricultural or lumbering activities of the pre-Hispanic population and the best explanation we can offer for the sudden reduction of Cyperacea in the spring area is that it was the product of artificial drainage. This is a critical point since it provides us with an initial date for canal irrigation in the Valley and it seems to have occurred towards the end of the Formative Period.

Kovar and I do disagree however on one point - over the possibility that some of the fluctuation of the pollen graph and lake history may be the product of minor climatic cycling. First, Lorenzo is incorrect in assuming that swidden agriculture was the only system practiced during the Classic period and one would expect a decrease in the rate of slope erosion, and hence lake sedimentation, during this period as contrasted to the Formative (in fact during Late Formative times some types of intensive agriculture were already in operation). Secondly, it is difficult to explain the internal cycling of lake levels present in Lorenzo's chart in terms of continuous deposition into the lake. Why does the level drop in Terminal Formative and Toltec times and rise again during the Aztec and Classic periods?

In summary the pollen graph seems to correlate well with Lorenzo's lake level fluctuations and the variations are probably the product of minor climatic cycling and human activities. Compared to climatic cycling during the Pleistocene, the variations seem very minor indeed, but we must remember that the Valley of Teotihuacan today has a precipitation pattern that is on the borderline between subhumid and semi-arid. An increase of a hundred millimeters of annual rainfall makes the difference between crop failure or success.

In summary I suggest a correlation of climatic, hydrographic and cultural events for the Valley between 800 BC and 1519 AD as follows:

1. During the Middle Formative Period, conditions were favorable for extensive agriculture. Precipitation and lake level were both maximal in quantity and height respectively.

2. In Late Formative, and especially Terminal Formative times, there was a reduction of rainfall and lowering of lake level. This was a crucial period for the farming population and in Terminal Formative times the stimulus for new ecological adaptation was considerable.

3. The Teotihuacan Period generally was as favorable for agriculture as the Aztec especially if intensive agricultural practices were in vogue.

4. The climate and lake level returned to Terminal Formative conditions in Early Toltec times. The Late Toltec Phase probably witnessed a gradual return to more favorable conditions.

5. The Aztec Period was one of return to favorable conditions.*

Another major change in the Valley as an agricultural resource that has occurred since the Conquest is the output of water from the springs. As previously stated, approximately 80 springs with a permanent water flow are located at San Juan Teotihuacan in the barrios of Puxtla and Maquixco. Gamio estimated an annual flow of 31,000,000 cubic meters of water. The measured flow of water in December, 1922, was 1500 liters per second (at the end of the rainy season). They estimated a probable average flow of 1000.

In 1955 the output had dropped to 588.6, a striking decline that is apparently the product of the perforation of artesian wells up valley by large land owners. This indicates that 60% more water was available in 1920 than is today. It is possible, considering the heavy erosion and deforestation that has occurred since 1519, that the volume of water was even greater at the time of the Conquest and the possibility of a considerably higher volume around the beginning of the Classic period is great. Mooser furthermore suggests that some of the streams in the Upper Valley that serve as tributaries of the Rio de San Juan today were either permanent streams in Classic times or had a greater volume of seasonal water.

He also claims that permanent springs were once located at the headwaters of the Arroyo Piedras Negras (now a seasonal stream) between Cerro Coronillas and Cerro Gordo with an estimated flow of 100-200 liters per second. A portion of the water was apparently channeled into reservoirs in the site - the balance would have been available for irrigation. The total volume of water available for irrigation agriculture in Classic times therefore was at least double, possibly several times that available today. (see Mooser, 1968 p. 34, 36)

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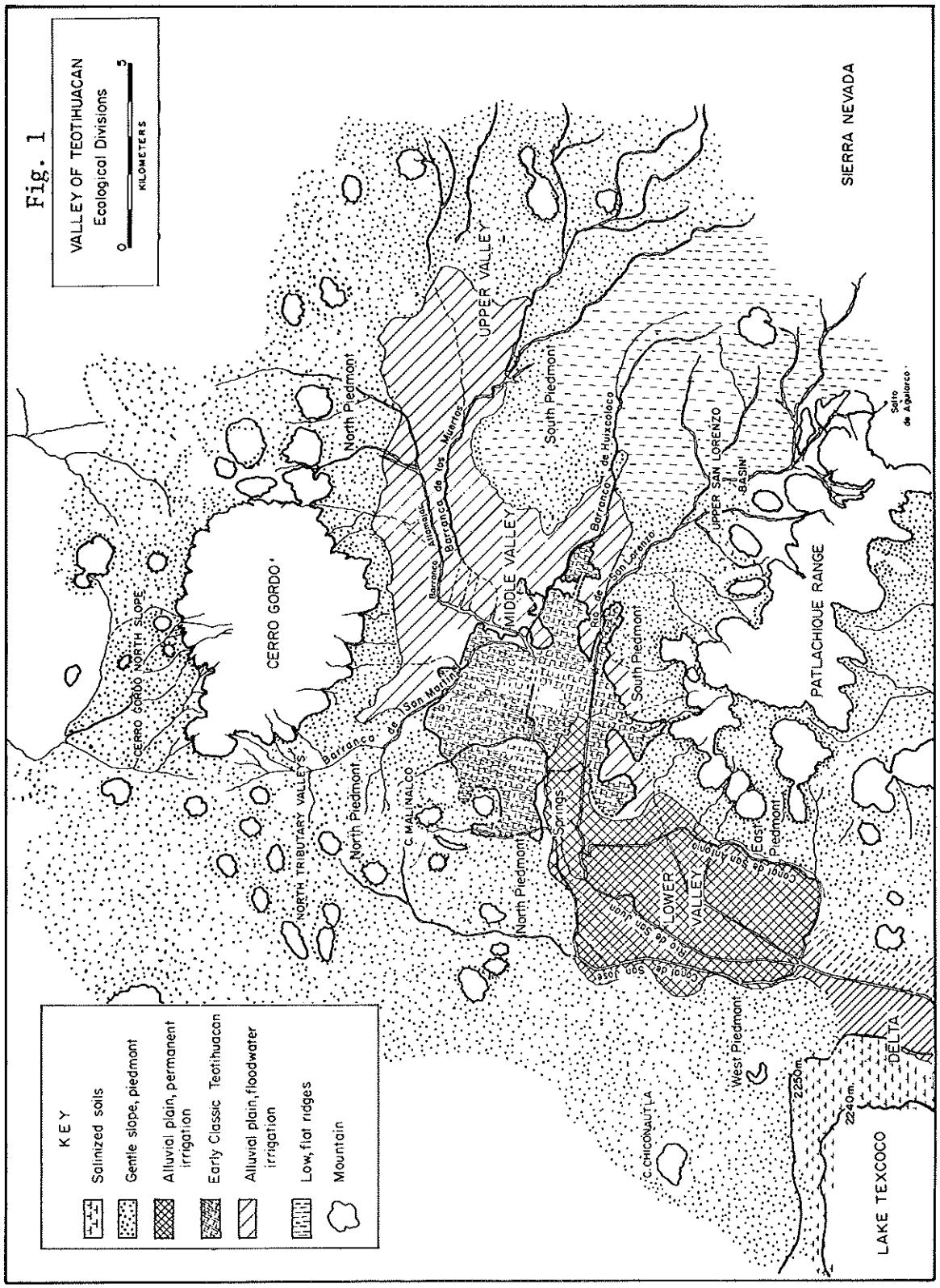
Fig. 1
VALLEY OF TEOTIHUACAN
Ecological Divisions
0
5
KILOMETERS
KEY
Salinized soils
Gentle slope, piedmont
Alluvial plain, permanent irrigation
Early Classic Teotihuacan
Alluvial plain, floodwater irrigation
Low, flat ridges
Mountain
CERRO GORDO
CERRO GORDO NORTH SLOPE
NORTH TRIBUTARY VALLEYS
Barranca de San Martín
North Piedmont
C. MALINALCO
Springs
North Piedmont
Barranca Allende
Barranca de los Muertos
UPPER VALLEY
MIDDLE VALLEY
South Piedmont
Barranca de Huixcoloco
Barranca de San Lorenzo
South Piedmont
UPPER SAN LORENZO BASIN
PATLACHIQUE RANGE
SIERRA NEVADA
Salto de Agua
LOWER VALLEY
East Piedmont
C. CHICONAUTLA
West Piedmont
2250m
2240m
DELTA
LAKE TEXCOCO

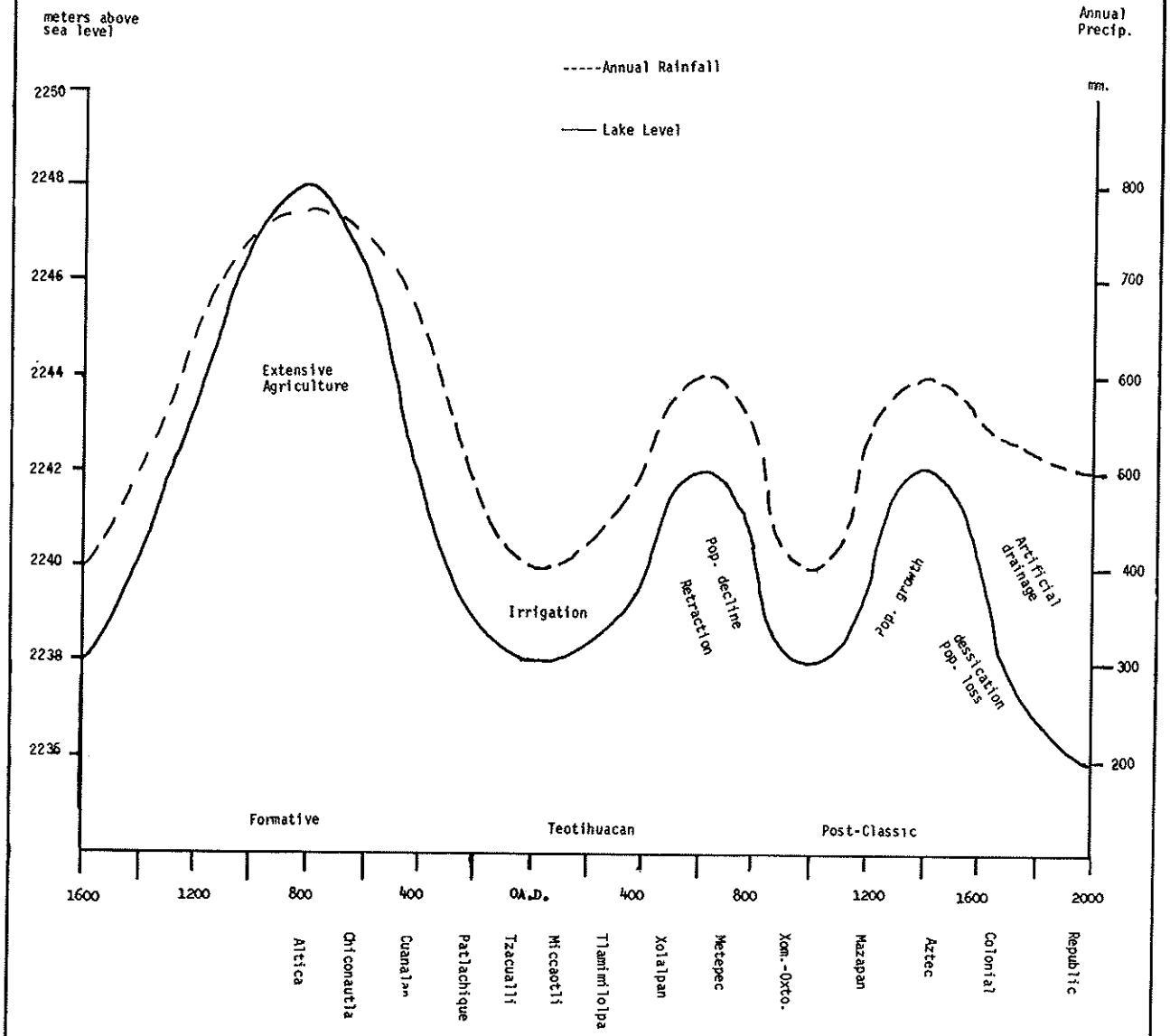

Figure 2. Changing Lake Levels and Precipitation in the Basin of Mexico. (Lake levels based on Lorenzo 1956:34)

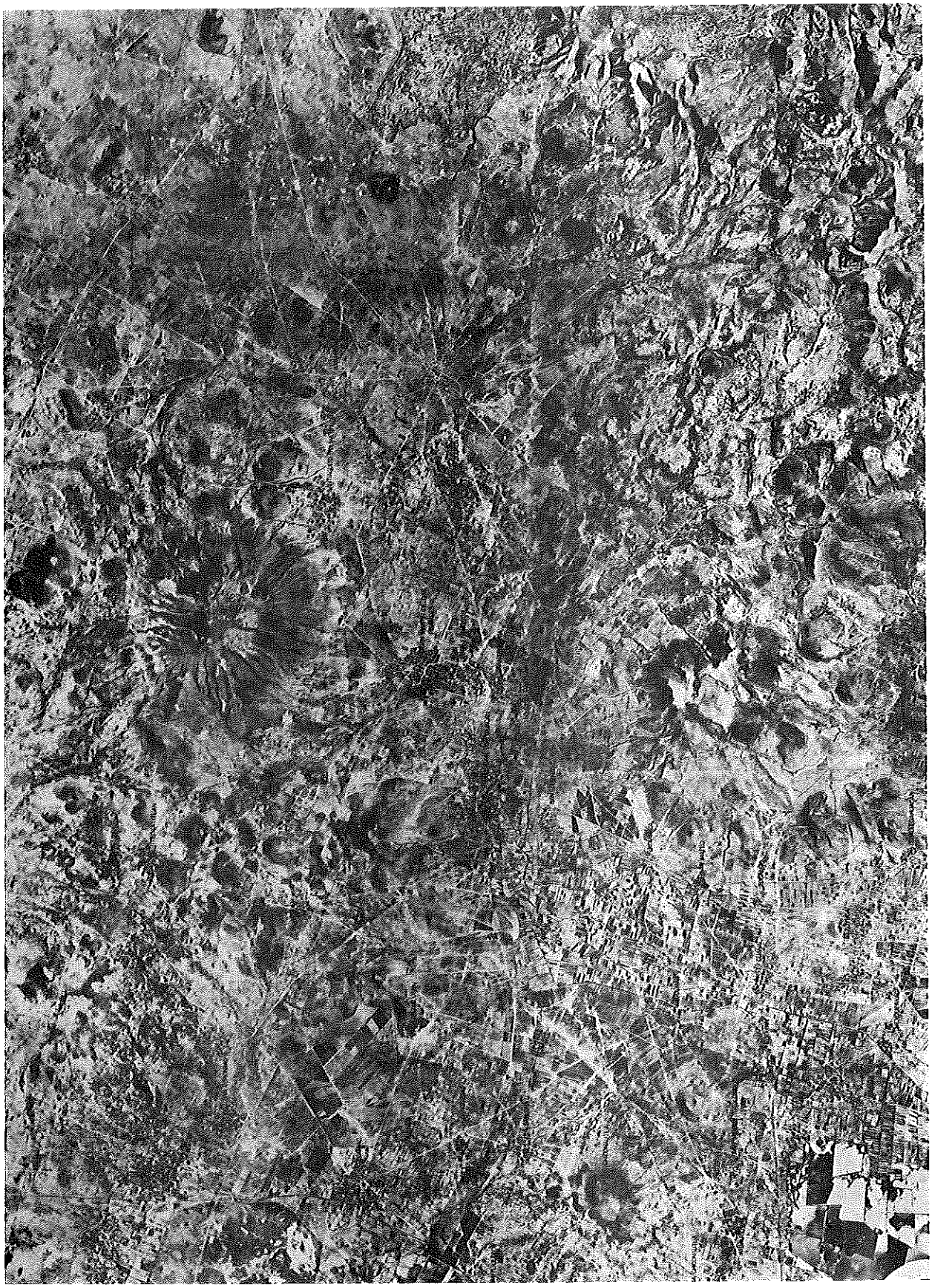

Plate 1

Plate 2

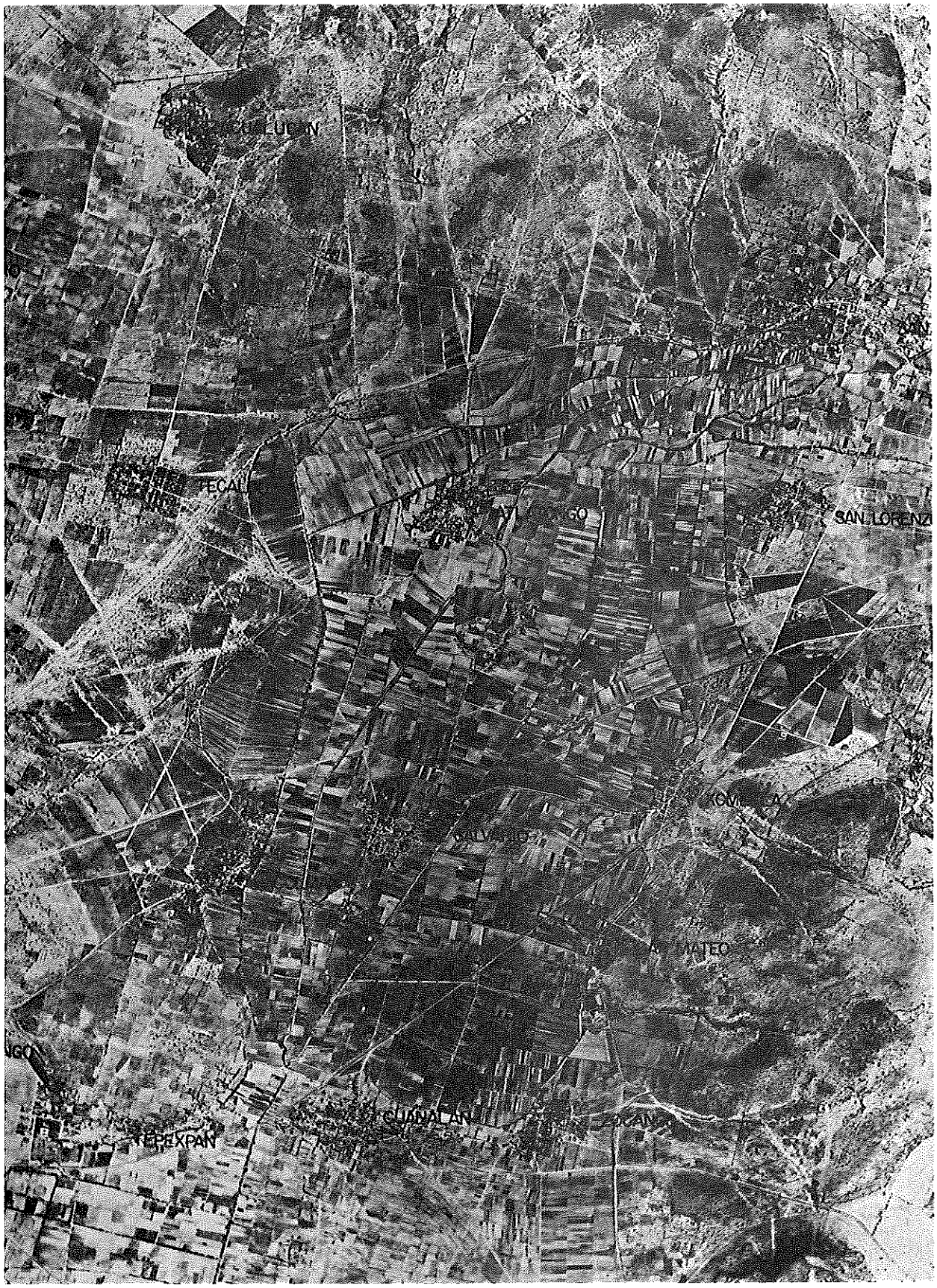

Plate 3

Plate 4

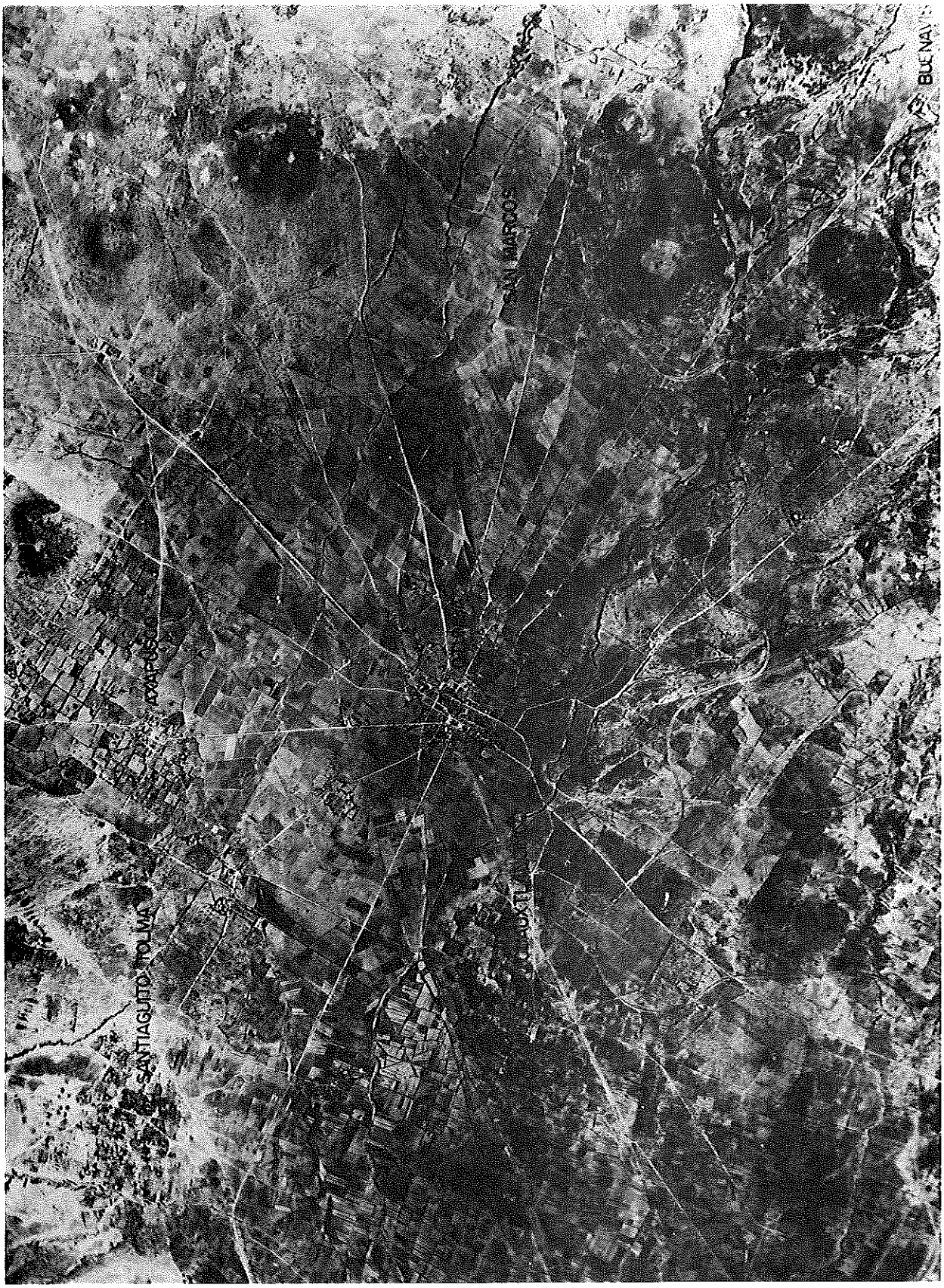

Plate 5

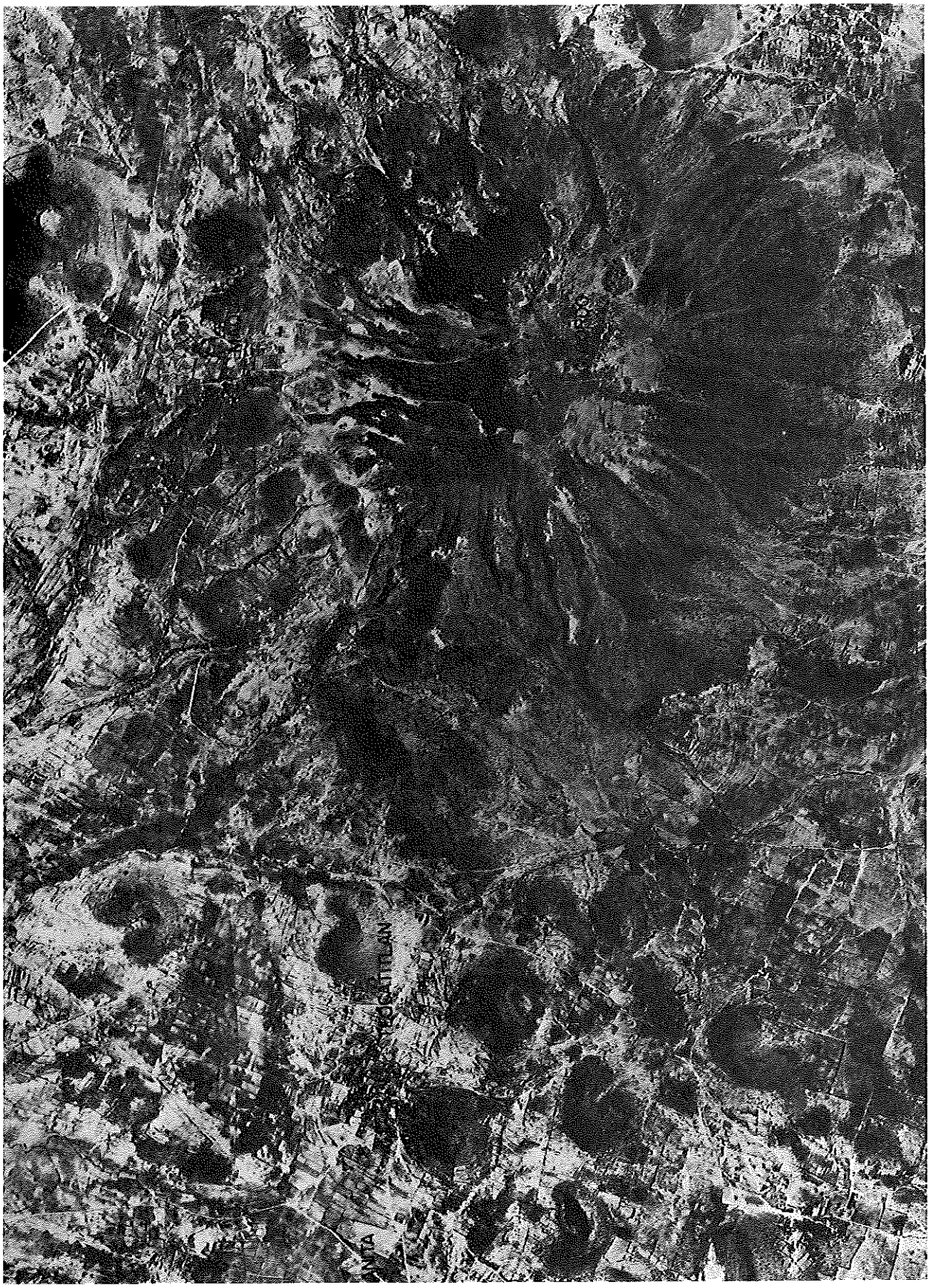

Plate 6

Plate 7

CONTEMPORARY SETTLEMENT PATTERNS IN THE TEOTIHUACAN VALLEY - AN OVERVIEW

by

Richard A. Diehl

TABLE OF CONTENTS

Introduction. 106

Political Geography of the Teotihuacan Valley 110

Methodology 116

Contemporary Settlement Patterns. 118
The Family - General 118
The Family in the Teotihuacan Valley 118
The Settlement Patterns of the Family 127
Urbanism and Barrio Organization at San Juan Teotihuacan 128
The Community in the Valley - The Four Community Study 135
The Community in the Valley - The General Survey 142
Zonal Settlement Patterns 151

Bibliography. 155-156

LIST OF ILLUSTRATIONS

MAPS

Map 1 San Juan Teotihuacan 157
Map 2 Cuanalan 157
Map 3 Santiago Tepetitlan 158
Map 4 Santa Maria Palapa 158

PLATES

Plate 1 - a. Aerophoto - San Juan Teotihuacan - Town. 159
Plate 2 - a. Aerophoto - Belen - Low Density Compact Village 161
b. Aerophoto - Otumba - Town. 161
Plate 3 - a. Aerophoto - Cuanalan - High Density Compact Village 163
b. Aerophoto - Xometla - High Density Compact Village 163
c. Aerophoto - Calvario Acolman - High Density Compact Village . . . 163
Plate 4 - a. Aerophoto - Cuahutlacingo - Scattered Village 165
Plate 5 - a. Aerophoto - Tlaltica - Rancheria 167
b. Aerophoto - Hacienda de Tepan 167
Plate 6 - 169
a. House Construction, Santiago Tolman . . . . . .
b. House with Maguey Penca Roof - Santiago Tolman . . . . . .
c. Adobe Wall Construction - San Juan Teotihuacan . . . . . .
d. House of Maguey Pencas - Palapa . . . . . .
Plate 7 - 171
a. Gateway to House Lot - Oxtotipac . . . . . .
b. Brick House with Teja Roof - Palapa . . . . . .
c. Stone House with Teja Roof - Oxtotipac . . . . . .
d. Abandoned Stone House Showing Construction Details - . . . . . .
Maquixco Alto
Plate 8 - 173
a. Paved Courtyard of Stone House . . . . . .
(Compact Type) - Maquixco Alto
b. Street in Oxtotipac, Note Organ Cactus House Lot Fence . . . . . .
c. Same House from Outside . . . . . .
Note Front Room - Shop
d. Dispersed House Lot - Oxtotipac . . . . . .
Plate 9 -. 175
a. Municipal Building - Oxtotipac . . . . . .
b. Church at Oxtotipac. . . . . .
c. Main Street - Oxtotipac. . . . . .
d. Adobe House - Atlatongo . . . . . .

Plate 10 - 177
a. San Juan Teotihuacan - Palacio Municipal. . . . . .
b. San Juan Teotihuacan - Central Plaza and One of Principal Streets . . . . . .
c. San Juan Teotihuacan - Pulqueria. . . . . .
d. San Juan Teotihuacan - One of Secondary Streets . . . . . .
Plate 11 - 179
a. Market at San Juan Teotihuacan. . . . . .
b. Market at San Juan Teotihuacan. . . . . .

INTRODUCTION

The study of contemporary settlement patterns is a relatively new development and one to which little attention has been paid. Only slowly are anthropologists realizing the value of such studies in interpreting the social, economic and political patterns of the communities with which they work. Vogt has defined settlement pattern as "the patterned manner in which household and community units are arranged spatially over the landscape." (Vogt, 1956, p. 174). Frequently, social and economic groups in a society live in areas which are spatially separated from other such groups and these spatial divisions may be noted on a settlement pattern map. The study of these distributions can be of great value in understanding the society in question.

Much of the contemporary settlement pattern research in Latin America has been done by cultural geographers such as Stanislawski, McBryde and West.

Stanislawski's work is best represented by his monograph The Anatomy of Eleven Towns in Michoacan (1950). This was an attempt to determine the effect of geographical factors on the physical layout of eleven communities in the state of Michoacan, Mexico. In his study he took into account community size, configuration, the amount of occupational specialization and the relation of the community to trade routes. On the basis of his survey, he concluded that the most important factor that influenced what he called the "character" of a community was its position relative to trade routes. He divided the communities into three categories: Hispanic town, Indian town and dual character town. The Hispanic towns are characterized by a well-defined plaza and a more or less rectilinear street pattern; social, economic and political prominence of trade and mercantile activities; and the high economic prestige of certain occupations such as merchant, mule driver and leather worker. The Indian towns lack plazas and street grid patterns. Indian crafts such as woodworking and weaving predominate over Hispanic-derived occupations. The dual character town is a combination of the two and exhibits some traits of each.

Another example of the cultural-geographical approach to the study of settlement patterns is that used by McBryde in his Cultural and Historical Geography of Southwestern Guatemala (1945). In it, he lists two general types of factors which affect settlement patterns and population density. The first are physical factors, the second cultural factors. The physical factors include terrain, water supply and altitude. Terrain is important because most of the Guatemala Highlands consists of steep slopes upon which house construction is difficult. The region is dissected by many barrancas; this further decreases the amount of habitable land. Many of the high mountain slopes could be utilized for settlement but they lack a permanent water supply. Altitude and climate combine to form another physical determinant of settlement. The 1500 meter contour is the upper limit of coffee and cacao cultivation. With the exception of the coastal plain, the area below this line is characterized by coffee and cacao plantations and subsistence farming is almost non-existent. Most of the area's inhabitants live on plantations and other types of settlements are quite rare. Coffee and cacao cannot be grown above the 1500 meter contour and this area is one of subsistence and truck farming. The greater part of the population of Guatemala is found within this upper belt. The main foci of population in this area are the villages and towns.

The primary cultural factor which affects Guatemalan settlement patterns and population density is economic specialization. This takes one of two forms

truck gardening and manufacturing. Most of the manufacturing is done by specialists. Ropes, hats, pottery and textiles are some of the products.

In his discussion of settlement patterns, McBryde defined a town as a community of over 1000 people, including at least 500 Ladinos. Communities with more than 1000 inhabitants but which lack the Ladino element are considered to be large villages. This is because the communities with a large Ladino population have many specialized services and full-time craftsmen. These services include stores, government offices, schools and medical facilities. He feels that a community may be considered a town only when such services are present.

The rectangular grid pattern introduced by the Spaniards is found almost universally in Guatemalan communities; despite this, the streets are almost never oriented to the cardinal points of the compass. This is attributed to the broken terrain which is generally taken into account much more by the inhabitants than any artificial orientation pattern.

Within the towns, the central section is generally occupied by the Ladinos who predominate socially, economically and politically. The Indians, on the lower end of the socio-economic scale, tend to live on the outskirts of the community. The central plaza is generally surrounded by the church, government buildings, the school and the army barracks. The larger shops are found near the center of the community.

The municipio is the smallest administrative unit in the Guatemalan political structure. In the area studied by McBryde, it is also the primary unit of cultural integration. Language, dress and economic activities tend to have more continuity within the municipio than they do between the municipios. These units were organized by the Spaniards in the sixteenth century and though occasionally the boundaries were set up arbitrarily and without regard to pre-existing cultural affinities, the majority followed pre-existing cultural lines. The municipio consists of the cabecera or central community and the surrounding area which is dependent upon it. The cabecera is generally the largest community in the municipio and is its social, economic, religious and political center.

Another cultural geographer who has dealt with settlement patterns in Latin America is Robert West. In his Cultural Geography of the Modern Tarascan Area (1947), he defined two contemporary community types in the Tarascan area of Mexico. They are the pueblo and the rancheria. The pueblos range in population from 200 to 3400 and the rancherias from 9 to 900. The pueblos are characterized by the Spanish grid pattern of streets and a central plaza. The school, government buildings and stores are grouped around the plaza. One unusual feature in this area is that the church is rarely found directly on the plaza; it is generally located one-half a block away with a large open space between it and the plaza. The area around the plaza is quite densely occupied, as one moves further away from the plaza, the houses are more dispersed and the grid pattern disappears.

The rancheria is similar to the Prehispanic settlements in the area in that the street pattern is quite irregular and the houses widely spaced. The individual rancheria house lots tend to be large. They generally contain a living structure, a pig pen, a kitchen, a burro shed and several storage buildings.

One of the best examples of settlement pattern research conducted by anthropologists is the work being done by Harvard University in highland Chiapas, Mexico. Though numerous books, monographs and papers have been published, the most significant report on settlement patterns is that by Vogt (1961). The area involved is occupied by Tzotzil-speaking Maya Indians. As with the Maya of highland Guatemala, the municipio is the primary unit of cultural integration.

The municipio of Zinacantan consists of a town by that name and numerous smaller communities which are dependent upon it The total population of the municipio was 7611 in 1960. The total population of the town of Zinacantan, including the Ladinos, was only 394 or about six percent of the municipio total. The rest of the population resides in scattered "hamlets" called parajes, which contain between 50 to 1200 inhabitants. The parajes are not really physical communities but rather districts and each consists of a number of smaller physical divisions called "waterhole groups". These comprise clusters of houses located near wells. Each "waterhole group" is made up of at least one and usually several patrilineages. The patrilineages quite often have a few non-patrilineal kin connected with them. Each patrilineage occupies a number of individual houses which contain patrilocal, extended families. The extended family residences include separate houses for each married son and his family.

The only previous study of contemporary settlement patterns in the Teotihuacan Valley was done by William T. Sanders, as presented in his unpublished doctoral dissertation, Tierra y Agua (1957). He distinguished two types of settlement patterns, community settlement patterns and zonal settlement patterns. Community settlement patterns refer to the individual settlement, its physical size, population size and density, plan, socio-economic characteristics and relationships to its immediate natural environment. The term zonal settlement pattern refers to settlement types, the spatial distribution and location of communities, their socio-economic interrelationships within a supra-community territorial unit. This unit may be a small local zone or an entire region.

Sanders found that most of the Teotihuacan Valley population lives in tightly nucleated settlements. These have central plazas bordered by a church, stores and local government buildings. Their population densities vary between 1150 and 5000 people per sq. km. (Based on the 1940 census). The Spanish grid pattern of streets is generally lacking except for the principal streets in the center. Several communities in the valley are referred to as compound communities. They contain two or more subdivisions known as barrios. The barrios are normally adjacent to each other, so the community appears to be a single entity from the air. Sanders found two distinct subgroups of tightly nucleated communities, based on population density: those within or on the edge of the irrigated plains with densities of between 3000 and 5000 per sq. km. and those on hillsides, the piedmont or within the nonirrigated plains with densities of 1150 to 2500 per sq. km. He attributed the lower densities of the latter group to the presence of large nopal orchards within the houselots. Each house in these communities is surrounded by a garden and the average houselot measures .4 hectares. He referred to the first community type as a "high density compact village", the second as a "low density compact village".

Sanders defined three types of non-nucleated settlements in the valley. They are the scattered village, the rancheria and the hacienda. The scattered villages occupy the piedmont strips adjacent to the valley plain and have quite low population densities (from 500-1000 per Km^2). They do have plazas. The

rancherias are even less nucleated than the scattered villages and lack central plazas. They are located in the badly eroded tributary valley north of Cerro Malinalco and their economies are based upon maguey and nopal exploitation.

Haciendas have almost completely disappeared from the valley and are of little demographic importance at the present time. Formerly, the haciendas in the Upper Valley specialized in pulque production while those in the Lower Valley produced basic grains such as maize, wheat and barley. The haciendas in the drier parts of the valley tended to be located near the headwaters of seasonal streams, thus assuring control over the rainy season runoff. Many haciendas were completely disbanded by the federal government in the 1920's. Others were left with much reduced land holdings which together with the main buildings is referred to as the casco of the hacienda. Many of these have changed their official designation from hacienda to rancho or granja.

POLITICAL GEOGRAPHY OF THE TEOTIHUACAN VALLEY

The municipio is the smallest political district in modern Mexico and all states are divided up into such units. Municipios contain a varying number of component physical and social communities. Each municipio has a cabecera or administrative center which is generally but not always the largest community in the municipio. The focus of municipio government is the palacio municipal or municipal building which is located on the principal plaza in the cabecera. Here the political head of the municipio (the presidente municipal) and his subordinates have their offices and all government meetings are held here. The palacio municipal is generally one of the most imposing structures in the community. The architecture is almost always Spanish colonial and buildings are generally kept in good repair.

The Teotihuacan Valley is divided into seven municipios. This does not mean that these municipios are confined to the Teotihuacan Valley; in reality, two of them extend beyond the valley boundaries but all of them have their cabeceras within the valley. The seven are Acolman, Axapusco, Nopaltepec, Otumba, San Martin de las Piramides, Teotihuacan and Tezoyuca. Small portions of three other municipios (Atenco, Temascalapa, Ecatepec) are found either within the valley or in the zone immediately north of it included in the archaeological survey.

As previously mentioned, each municipio is made up of a varying number of component communities. The municipios in the Teotihuacan Valley have from two component communities (Tezoyuca) to forty (Teotihuacan). These component communities are classified under a variety of headings in the official censuses. The meaning of the various terms varies from state to state within Mexico and we have here defined the terms as they are used in the Teotihuacan Valley.

Some of the terms were applied to settlements during the Colonial Period, and derive from the 16th century nomenclature used by the Spanish government. Although the terms did refer to sociological characteristics of settlements; generally speaking, they were prestige titles awarded by the Crown. The term ciudad, for example, refers to a large, politically important center with urban characteristics; pueblo generally refers to a politically dependent but nucleated rural settlement. Most of the large nucleated Indian settlements were designated as pueblos after the Conquest, with the exception of large urban centers like Tenochtitlan, Texcoco, and Cholula, which were awarded the title of ciudad. The title villa, was awarded to some Indian communities and to some Spanish settlements, in both cases, designating communities in between pueblos and ciudades in political rank and urban characteristics.

Other titles such as rancheria, rancho, ejido, colonia agricola and hacienda are of more recent origin and their meaning varies considerably from state to state within Mexico. We have presented below a list of terms used in the census of our survey area and their local meaning. Following these definitions we have included the census of 1960, (Table 1) which provides population data and official classifications of each settlement in the survey area plus some demographic data from earlier censuses.

Ciudad - the only settlement with this title in the valley is Otumba. Otumba, as shall be demonstrated later, is an urban community, the cabecera

of a municipio and the center of a regional market. It also enjoys the highest political status of any community in the valley since it is the center of a judicial district, a political division between the municipio and the estado or state. This district includes the Upper Valley of Teotihuacan plus considerable territory outside of our survey area. The remainder of the valley pertains to the judicial district of Texcoco, a community located outside our survey area.

Villa - the only community with this rank is San Juan Teotihuacan. It is a municipal cabecera, the center of a regional market and is highly urbanized.

Pueblo - these are nucleated, (although as we have noted, the population density varies considerably) essentially rural, settlements. In all but two municipios, Otumba and San Juan Teotihuacan, the cabeceras are of pueblo rank and a certain degree of urban development has occurred as a consequence of this political rank. Most pueblos are dependent political communities. All lack commercial establishments or have a few small shops.

Barrio - a barrio may be either a physically discrete nucleated settlement indistinguishable in its appearance from a pueblo or it may be physically a part of a villa or pueblo. The term apparently represents a continuation of the Aztec system of nomenclature in which all rural settlements and divisions of major centers were designated as calpulli, a term the Spaniards translated as barrio. Why certain rural settlements in the valley after the Conquest retained the barrio status whereas others were designated as pueblos is not entirely clear. Today, one major difference between barrio and pueblo is in political status: the former lack discrete political status whereas the latter have an elected official (the delegado) who represents the community to the municipal government.

Ejido or colonia agricola - this is a new community type in the valley. When the federal government appropriated hacienda lands in the 1920's, the lands were mostly assigned as ejidos to local people residing in pre-existing villages. In some cases, however, new settlements were founded on the lands and are referred to as ejidos or colonias agricolas.

Hacienda - this term traditionally refers to a large, privately owned, agricultural estate. At the time of the agrarian reforms, there were perhaps a dozen or so such holdings which included most of the land in the valley. After the reforms, a few haciendas managed to retain relatively large holdings (but still within the limits established by the reforms) and continue functioning. In some cases they have changed their titles or designation to rancho.

Rancho - granja - generally speaking the term rancho refers to a relatively large holding of private land that is either the remains of an hacienda that has survived the agrarian reforms or represents a recent development of large holdings by private landowners. Most ranchos are devoted to livestock raising. The term granja also refers to a relatively large holding in which livestock is raised, but in which the livestock is primarily in the form of poultry. Many of these settlements lack permanent resident population.

Rancheria - this is a rural settlement similar to the pueblo and barrio in its economic and social characteristics but differs in two significant ways.

First, it is usually a much more diffuse settlement (in some cases with internal population densities of less than 200 per square kilometer) and there is much more agricultural land placed between the houses. Secondly, rancherias lack formal plazas.

Minor types - other types of units included in the census are railroad stations with permanent residents, an orphanage, power stations, petroleum pumping stations and the archaeological zone. Some of these lack permanent resident populations.

In Table 2, we have classified the social communities of the valley by population size categories (based on the 1960 census). The barrios of the same physical community have been tabulated separately. In terms of actual population distribution less than 2% of the valley population resided in settlements of less than 100 inhabitants, 36% in communities with from 100 to 1000 inhabitants and 62% lived in communities with more than 1000 inhabitants. Most of the small settlements (35 of the 44 with populations from 1-250 inhabitants) are located in the badly eroded piedmont of the Upper Valley and are classified in the census as ranchos, rancherias, haciendas and the grouping that we classified as minor types.

TABLE 1

20th Century Population of the Teotihuacan Valley by Municipio and Community

Municipio	Area (Km^2)	Area (Km^2)	1900	1910	1930	1940	1950	1960	Area Within Valley
Acolman	86.29	52.47	5822	5222	5827	7234	9422	12230	All
Atenco	72.24		3848	3275	4463	5023	5425		1/3
San Martin	57.79	58.72	NON-EXISTENT		3717	4171	4718	5425	All
Teotihuacan	75.41	68.71	5175	5570	5418	6667	8348	10477	All
Tezoyuca	25.93	17.49	1837	1709	1960	2161	2531	3424	All
Axapusco	256.51	284.83	N	7944	7049	7662	7598	8073	1/3
Nopaltepec	76.20	88.23	O	2580	2333	2709	2931	4773	2/3
Otumba	172.59	204.88	D	11264	7167	7584	8407	10455	All
Temascalapa	147.85	144.91	A	7074	7304	8136	8191	8955	1/4
Ecatepec	143.30	133.67	T A	7320	8762	10501	15226	40815	1/6

Acolman	1910	1940	1960	Community Type
Acolman	342	660	1062	Pueblo
Cuanalan	884	1061	1541	Pueblo
Granja de Acolman			80	Escuela Rural
Nextlalpan	43	-	-	Ro.
Sacango	162	186	332	Barrio
S. Antonio Acolman	173	13	39	Hac.
S. Bartolo Acolman	298	311	736	Pueblo
S. Juanico	95	203	277	Barrio
S. Lucas	114	154	153	Barrio
S. Marcus	273	448	666	Barrio
S. Mateo Chipiltepec	622	766	1157	Pueblo
S. Miguel Totolcingo	246	660	850	Pueblo
S. Pedro Tepetitlan	143	167	439	Ejido
S. Catarina	396	437	592	Pueblo
S. Maria	85	115	362	Barrio
Tenango	132	206	247	Barrio
Tepexpan	972	1179	2619	Pueblo
Xometla	423	668	1058	Pueblo
S. Jose	108	-	-	Hac.
Tepexpan	49	-	-	Hac.

	1910	1940	1960	Community Type
Axapusco				
Axapusco		1040	1010	Pueblo
Axulta				Hac.
Luz y Fuerza				Camp.
Campero			9	FFCC.
Francisco Madero			185	Ra.
Guadelupe Relinas		565	579	Pueblo
Hueyapan			50	Hac.
Ignacio Ramirez		555	450	Pueblo
Jaltepec		1208	1406	Pueblo
La Palma			10	FFCC.
Salinas			8	Hac.
S. Antonio Ometusco		118	260	Ejido
S. Felipe Zacatepec		471	426	Pueblo
S. Miguel Ometusco		218		FFCC.
S. Miguel Ometusco		224	235	Hac.
Tezoyuca				
Tezoyuca	1406	1348	2256	Pueblo
Tequisistlan	440	813	1168	Pueblo
Atenco				
Nexquipaya	1218	907	1310	Pueblo
Ixtapa	752	964	1767	Pueblo
Ecatepec				
S. Maria Chiconautla		957	1335	Pueblo
Venta de Carpio				Ro.

	1910	1940	1960	Community Type
Nopaltepec				
Nopaltepec		918	1193	Pueblo
La Puerta			11	Ro.
La Reforma			8	Ro.
S. Felipe Teotitlan		942	1090	Pueblo
S. Miguel Atepoxco		419	357	Hac.
S. Ines Amiltepec			29	Ro.
Tecpatepec			0	Ro.
Tepetzingo			5	Ra.
Tlaxixilco El Chico			45	Ra.
Tlaxixilco El Grande			16	Ra.
Venta de Cruz		207	112	FFCC.
S. Domingo Aztacameca		542	687	Pueblo
Soapayuca				Hac.
Tecuautitlan		232	281	Ejido
Tecuautitlan				Ro.
Tepepantla		100	90	Ejido
Xala		279	339	Ejido
Xuchi		224	263	Ra.
Zacatepec		245	247	Ra.
S. Francisco Metepec		121	-	Col. Ag.
Temascalapa				
S. Cristobal Colhuacan		326	306	Pueblo
S. Juan Teacalco		888	812	Pueblo
S. Maria Maquixco		439	408	Pueblo

	1910	1940	1960	Community Type
Otumba				
Otumba		1560	1919	Ciudad
Aguatepec		466	569	Pueblo
Belen		653	988	Pueblo
Buenavista		220	369	Ra.
Coamilpa		-	193	Col. Ag.
Coamilpa		128	92	Ra.
El Colorado			83	Ro.
Coyotepec			181	Ro.
Cuahutlacingo		718	931	Pueblo
Cuatengo			9	Ro.
Mayorazgo			2	Ro.
Oxtotipac		638	684	Pueblo
Pabellon			32	Ro.
Papas			5	Ro.
Poyoxco			8	Ro.
S. Cosme			-	Barrio
S. Emilio			-	Ro.
S. Francisco Tlaltica		378	544	Pueblo
S. Lorenzo			6	Ro.
San Marcos		593	851	Pueblo
S. Miguel Axalco				Ro.
S. Miguel Xolco		207	124	Pueblo
S. Barbara		413	478	Ra.
S. Tolman		1004	1567	Pueblo
Segundo El Calvario			90	Hac.
Tepa			2	Hac.
Tlalmimilolpa		199	115	Barrio
Tlaltecahuacan			40	Hac.
Tlahuico			5	Ra.
Tocuila			79	Ra.
Trinidad			248	Barrio
Xalmimilolpa		159	227	Barrio
Xochihuacan			14	Hac.
San Martin de las Piramides				
San Martin		2243	3197	Pueblo
Alvaro Obregon			72	Col. Ag.
Caltepec				Ro.
Cerro Gordo				Hac.
Ixtlahuaca		307	539	Ra.
Pedregal				Ro.
Piramides				Camp.
S. Antonio de las Palmas			217	Barrio
S. Pablo Ixquitlan		351	479	Pueblo
S. Maria Palapa		364	388	Ra.
S. Tepetitlan		427	536	Pueblo
Tezompa		147		Ra.
Tlacatecpan				Hac.
El Salto		51		Barrio
Tlachinolpan		72		Ra.

Teotihuacan	1910	1940	1960	Community Type
Teotihuacan	739	1353	2294	Villa
Arruza				Granja
Atlatongo	707	888	1145	Pueblo
Azteca				Ro.
Cadena	191			Ro.
Canadas				Ro.
Carmen				Gr.
Clarita				Gr.
Cosotlan	56	60	49	Ra.
Cruces				Ro.
Chalma Guadelupe				Ro.
Chapos				Ro.
Estacion Pemex				Estacion
S. Juan Evangelista	327	329	665	Barrio
Huixcololco				Barrio
Kilometro	42			Camp.
Maquixco	305	459	673	Barrio
Margarita				Gr.
Metepec	135			FFCC.
La Palma				Ro.
Parroquia				Ro.
Progreso			92	Col. Ag.
Purificacion	452	752	1373	Barrio
Puxtla	147	166	205	Barrio
Quetzalcoatl				Gr.
S. Agustin Aticpa	225	174	278	Barrio

	1910	1940	1960	Community Type
S. Francisco Mazapan	523	658	1143	Pueblo
S. Juan				Ro.
S. Lorenzo Tlalmimilolpa	186	434	769	Barrio
S. Mateo				Ro.
S. Sebastian				Gr.
S. Sebastian	308	448	1013	Barrio
S. Ana				Ro.
S. Catarina	133			Hac.
S. Maria Coatlan	221	269	517	Barrio
Teotihuacan				FFCC.
Tlajinga	80			Hac.
Ventilla				Ro.
Zacualuca	230	256	261	Pueblo
Zona Arqueologica				Zona Arq.

Key

Hac. ----------Hacienda
Ro.----------Rancho
Ra.----------Rancheria
Camp.----------Campomento
Gr.----------Granja
Col. Ag.----------Colonia Agricola
FFCC.----------Railroad Station

Table 2

Teotihuacan Valley - Classification of Communities by Size Categories

	1-100	101-250	251-500	501-1000	1001-2000	2001-3000	3000-4000
Acolman	2	2	4	4	4	1	0
Axapusco	5	3	6	2	2	0	0
Otumba	14	6	2	6	2	0	0
S. Martin	1	1	2	2	0	0	1
Ecatepec	0	0	0	0	1	0	0
Tezoyuca	0	0	0	0	1	1	0
Teotihuacan	2	1	2	4	4	1	0
Temascalapa	0	0	2	1	0	0	0
Atenco	0	0	0	0	2	0	0
Nopaltepec	6	1	1	0	2	0	0
	30	14	19	19	18	3	1

Table 3 is a summary of settlement types in the valley by census categories.

Table 3

Teotihuacan Valley - Types of Communities in Census

	Ciudad or Villa	Pueblo	Barrio	Rancheria	Granja or Rancho	Ejido Colonia Agricola	Hac.	Misc.
Acolman		8	6		1	1	1	1
Axapusco		6	0	3	1	5	5	4
Otumba	1	8	4	6	9	1	4	0
S. Martin		3	1	3	2	1	2	1
Ecatepec		1			1			
Tezoyuca		2						
Teotihuacan	1	3	8	1	21	0	1	5
Temascalapa		3						
Atenco		2						
Nopaltepec		2		3	4		1	1
	2	38	19	16	39	8	14	12

METHODOLOGY

The field study of contemporary settlement patterns was conducted during the period from June to December, 1963. Two different methods of data collection were employed. They were:

1. The administration of a questionnaire
2. The preparation of maps of selected communities in the valley.

A questionnaire survey was administered by the investigator and a native informant to the inhabitants of four valley communities. The questionnaire is reproduced in Appendix A. It was drawn up by William T. Sanders and the investigator. The questions were designed to supply data on numerous topics, including, family size and composition, ages of individuals, place of birth, occupation, land holdings, crops planted; and certain preferences in family composition, house type and place of residence. This questionnaire was administered from house to house, and the answers were recorded in notebooks with one page devoted to each responding household. The four communities in which the questionnaire was administered were Cuanalan, San Juan Teotihuacan, Santiago Tepetitlan and Santa Maria Palapa.

Cuanalan was chosen because it is a large, compact, rural community located on the Lower Valley plain within the area of permanent irrigation. The project had carried out archaeological excavations in the community in 1961-1962 and the inhabitants were amicably disposed toward project personnel. Time limitations prevented the questioning of each householder in Cuanalan. Thus a portion of the community was chosen for survey and the rest excluded. The censused portion extended from one edge of the community to the other, cutting through the center of the village along an east-west axis (See Map 2). Seventy-three households were surveyed, they contained a total of 435 individuals (approximately 30% of the population of the village).

San Juan Teotihuacan was chosen for several reasons. First, it is the largest and most urban-appearing community in the valley. Second, it is situated on top of the springs which feed the Lower Valley irrigation system and throughout the history of the community this critical location has had striking effects on the social and economic life of the settlement. Third, it is superimposed on the ruins of the capital of an Aztec city-state and the site has been continuously occupied since the Conquest, thus offering possibilities for historical reconstruction. The community is divided up into five barrios, four of which form the physical town of San Juan Teotihuacan itself. The fifth lies two kilometers to the west. The four barrios which comprise the physical community are San Juan Evangelista, Purificacion, La Villa and Puxtla. The physically detached barrio is called Maquixco. The four conjoined barrios were surveyed and an attempt was made to question each household in the town. Data was obtained on 71 households in San Juan Evangelista, in La Villa, the total was 184; in Puxtla, 27 and in Purificacion, 67. The La Villa, San Juan Evangelista and Puxtla totals include all barrio residents except those who were not home or who refused to answer. The Purificacion sample is incomplete. While this barrio was being surveyed, a group of inhabitants initiated organized resistance and the investigator thought it wiser to abandon the project in that particular barrio. The total number of families in the compound community of San Juan Teotihuacan who responded was 394, the total population included was 1850 individuals.

Santiago Tepetitlan, the third community in which the questionnaire was administered, is a small village on the flanks of the Patlachique mountain range. It was chosen because it occupies an area of rainfall and terrace agriculture (in contrast to the permanent irrigation used southwest of San Juan Teotihuacan) and also because of its geographical position. Its location allows it to exploit the three major ecological zones of the valley; the alluvial plain, the piedmont and the high mountain slopes. The village is located on a series of artificial terraces on the piedmont. The questionnaire was administered to the entire community and data was collected on 32 families and 193 individuals.

The fourth community in which the questionnaire was administered was Santa Maria Palapa, which is scattered over the flanks of Cerro Gordo on the northern periphery of the valley. The houses are widely spaced and the population density is extremely low. An attempt was made to contact every householder in the community, 59 households responded, representing 287 individuals.

The total number of households for which data is available in the four communities is 558 with a total population of 2,765 individuals.

The second data collecting technique involved mapping fourteen communities in the valley. The project photographer (William Mather III) prepared a series of amplifications of aerial photographs for the entire valley, to a scale of 1::4,000. Tracings were made of the street plans of the selected communities putting in as much detail as could be noted on the aerial photographs. Each community was then visited to check the accuracy of the map. Notes were taken on the general characteristics of the community and the presence of schools, churches, government buildings, stores and indications of occupational specialization. The communities surveyed were:

1. Atlatongo
2. Axapusco
3. Belen
4. Calvario Acolman
5. Cuanalan
6. Maquixco
7. Otumba
8. San Francisco Mazapan
9. San Juan Teotihuacan
10. San Martin de las Piramides
11. Santa Catarina Acolman
12. Santa Maria Palapa
13. Santiago Tepetitlan
14. Zacualuca

These communities represent wide variations in size, population density, political status and apparent degree of urbanism and all ecological zones and areas. This work was done without an informant.

CONTEMPORARY SETTLEMENT PATTERNS

The Family - General

Ethnological studies have shown that contemporary Mexicans are organized into several types of social groups. The family, the barrio and the community are three examples. The first has a kin based structure, the others do not.

The most universally-met with group in which human beings participate is the nuclear family. Murdock has defined it as consisting "typically of a married man and woman with their offspring, although in individual cases one or more additional persons may reside with them" (Murdock, 1949, p. 1). Concerning the functions of the nuclear family, Murdock says, "whatever larger familial forms may exist, and to whatever extent the greater unit may assume some of the burdens of the lesser, the nuclear family is always recognizable and always has its distinctive and vital functions--sexual, economic, reproductive, and educational..." (Ibid., p. 3).

The functions of the nuclear family noted by Murdock are universal or very nearly so, but they are not the only ones it may have. Other possible functions are landholding, determination of the rank of the individual, and participation in religion. These latter functions are not universal but they are important in the Teotihuacan Valley.

The Family in the Teotihuacan Valley

The nuclear family is one of the primary socio-economic groups to which a Teotihuacano belongs. Extended families are also found in the valley. Murdock has defined the extended family as one which "...consists of two or more nuclear families affiliated through the parent-child relationship rather than the husband-wife relationship, i.e.., by joining the nuclear family of a married adult to that of his parents." (Ibid, p. 2).

Preference for nuclear over extended family residence in the valley is demonstrated by the responses to two questions in the house-to-house survey. Question six concerned the relationship of household residents to each other. On the basis of these responses, the investigator later classified the resident groups as nuclear or extended families. Data was collected from 558 households, of these, fifty-two responses were discarded because there was reason to believe they were unreliable. This left 506 reliable responses. Three hundred fifty-one or 69% of all the households were classified as nuclear family residences (Table 4). Almost all the cases counted as nuclear families consisted of a man, his wife and their children. If one parent was dead or not living with the family and the children were young, the group was counted as a nuclear family. Cases in which the basic nuclear family was augmented by a non-primary relative or a non-related person were also included in this count. This latter occurrence accounted for only twelve cases of the 351.

Another indicator of the popularity of nuclear family residence was the response to Question 10, which dealt with the preference for living in a nuclear or extended family unit. Three hundred fifty-four responses were considered reliable.

Table 4

Familial Residence Patterns in the Total Sample, Based on Question Six

	Number	Percentage of the Total
Nuclear Family Residence	351	69
Extended Family Residence	155	31
	506 Total	100 Total

Table 5

Preference for Nuclear or Extended Family Households in the Total Sample, Based on Question Ten

	Number	Percentage of the Total
Preference for Nuclear Family	255	72
Preference for Extended Family	99	28
	354 Total	100 Total

There is an explanation for this relatively low number. This question and questions 8 and 9 dealt with preferences. Though they would seem to be the most innocuous of all the questions on the list, they caused more concern among the respondents than any other questions. At the time of the investigation, the Mexican government was conducting a major restoration project on the archaeological zone at Teotihuacan. The construction of a new highway from Mexico City was an integral part of this project. At this time the exact highway route had not yet been selected. Upon hearing the preference question, numerous people began to suspect that the highway was going to be placed on their land and that the investigator was asking these questions in order to determine where to move them, what type of house to build for them, etc. This led to numerous difficulties and more than one interview was abruptly terminated at this point. In view of them, the investigator asked these questions at his own discretion. For example, they were completely deleted in Santa Maria Palapa because of local suspicions about the proposed highway.

Of the 354 reliable responses to Question 10, 255 or 72 percent indicated a preference for nuclear family residence (see Table 5). The reasons for this preference were not asked but the most popular ones offered voluntarily were desires for privacy and social independence.

Analysis of extended families presents certain problems. Adhering closely to Murdock's previously quoted definition, 155 of the 506 cases (31 percent) counted reside in an extended family. The problem is that the majority of these cases fit the definition as worded but do not fit its intention. Murdock clearly indicates what he has in mind is a regularized pattern in which all or most of the married adult offspring of one sex reside with their parents, bringing their spouses into the parental residential unit. This is not the case in the Teotihuacan Valley. The majority of the cases counted as extended families involve situations in which aged parents have moved in with a married child. The parent is often a widow or widower. Another situation found in the valley is one in which a young married couple resides with one of the spouses' parents for a year or so until they have the economic means to establish a separate residence. Though data is lacking, there seems to be no definite tendency towards matrilocality or patrilocality in such cases.

The responses to the question on preference for living arrangements agree with what has been said previously. Ninety-nine of the 354 responses counted indicated a preference for extended family residence; that figure represents 28 percent of the total sample. Reasons for this preference were not requested but the ones most frequently mentioned were that it would be "friendlier" and there would be more people to do the work.

The percentages of households which fit into the nuclear family category in each community are as follows: Cuanalan - 64 percent, San Juan Teotihuacan - 68 percent, Santiago Tepetitlan - 71 percent and Santa Maria Palapa - 81 percent. (See Table 6).

The percentages of households which listed the nuclear family residence as their preference are as follows: Cuanalan - 74 percent, San Juan Teotihuacan - 71 percent and Santiago Tepetitlan - 75 percent. (See Table 7). As previously stated, this question was not asked in Santa Maria Palapa.

A total of 385 nuclear families were interviewed in the study. This figure includes the 351 families classified as nuclear plus 34 additional ones which formed part of an extended family but in which the total number of members in each nuclear family could not be readily identified in the field notes.

Table 6

Familial Residence Patterns in Each of the Four Communities, Based on Question Six

Community	Nuclear Family Residence		Extended Family Residence	
	Number	Percent	Number	Percent
Cuanalan	44	64	24	36
San Juan Teotihuacan	236	68	110	32
Santiago Tepetitlan	24	71	10	29
Santa Maria Palapa	47	81	11	19
	351		155	

Table 7

Preference for Nuclear or Extended Family Households in Each of the Four Communities, Based on Question Ten

Community	Preference for Nuclear Family Residence		Preference for Extended Family Residence	
	Number	Percent	Number	Percent
Cuanalan	43	74	15	26
San Juan Teotihuacan	197	71	79	29
Santiago Tepetitlan	15	75	5	25

The number of members in each nuclear family was tabulated (Table 8). The range of the sample was from 2 to 14 members per nuclear family. The majority of the nuclear families in all four communities had five members or less; in Cuanalan, 58 percent had five members or less; in San Juan Teotihuacan, 53 percent; in Santiago Tepetitlan, 59 percent and in Santa Maria Palapa, 62 percent had five or less (Table 9). The percentage of nuclear families in the entire sample with five members or less is 55 percent.

The modal nuclear family size in the entire sample is 4 individuals, with a total of 63 cases (16 percent of all nuclear families). Some variation among communities exists in this calculation; the mode in Cuanalan is four persons, accounting for 26 percent of all nuclear families; in San Juan Teotihuacan, it is also four persons, representing 15 percent of the total; in Santiago Tepetitlan, it is 3 persons, accounting for 26 percent of the total and in Santa Maria Palapa, it is 5 persons, accounting for 18 percent of the total (Table 9).

A tabulation was made of the number of people per household in the sample. Four hundred eighty-eight reliable responses from the four communities were included. These included both nuclear and extended family residences. The majority of the inhabitants of the four communities live in households of 6 persons or less, in fact, 60 percent of the households contain 6 people or less. The modal number of people per household is three; this category accounts for 13 percent of the total number of households (Table 10). The modal number per household in Cuanalan is 4, with 12 cases representing 22 percent of the sample. The modal number in San Juan Teotihuacan is 3, representing 21 percent of the total. In Santiago Tepetitlan, the mode is also 3, 21 percent of the total. In Santa Maria Palapa, 2 household sizes occupy the modal position, households of 3 and 5 members account for 15 percent of the total. (Table 11).

Table 8

Size of Nuclear Families
in the Total Sample,
Based on Questions One and Six

Number of Members	Number of Cases	Percentage of Total
2	53	14
3	47	12
4	63	16
5	49	13
6	53	14
7	44	11
8	23	6
9	22	6
10	18	5
11	6	1
12	3	1
13	2	.005
14	2	.005
	385 Total	100 Total

Table 10

Sizes of Households
in the Total Sample,
Based on Question One

Number of People	Number of Cases	Percentage of Total
1	17	3
2	47	9
3	67	13
4	53	13
5	57	11
6	57	11
7	50	13
8	37	7
9	31	6
10	30	6
11	12	2
12	8	2
13	10	2
14	4	1
15	4	1
16	2	.005
17	2	.005
	488 Total	101 Total

TABLE 9

Size of the Nuclear Family
in Each of the Four Communities,
Based on Questions One and Six

Number of People in Family	Cuanalan		San Juan	Teotihuacan	Santiago	Tepetitlan	Santa Maria Palapa	
	Number of Cases	Percentage of Total	Number of Cases	Percentage of Total	Number of Cases	Percentage of Total	Number of Cases	Percentage of Total
2	7	14	36	14	2	9	8	16
3	4	8	30	11	6	26	7	14
4	13	26	41	15	2	9	7	14
5	5	10	33	12	2	9	9	18
6	9	18	36	14	4	17	4	8
7	4	8	31	12	2	9	7	14
8	2	4	15	6	3	13	3	6
9	1	2	17	6	1	4	3	6
10	3	6	13	5	0	0	2	4
11	0	0	5	2	1	4	0	0
12	0	0	3	1	0	0	0	0
13	0	0	2	1	0	0	0	0
14	0	0	2	1	0	0	0	0
TOTALS	48	96	264	100	23	100	50	100

TABLE 11

Size of Household in Each of the Four Communities
Based on Question One

Number of People in Household	Cuanalan		San Juan	Teotihuacan	Santiago	Tepetitlan	Santa Maria	Palapa
	Number of Cases	Percentage of Total	Number of Cases	Percentage of Total	Number of Cases	Percentage of Total	Number of Cases	Percentage of Total
1	1	2	11	3	2	6	3	5
2	8	15	31	9	1	3	7	12
3	6	11	45	13	7	21	9	15
4	2	22	41	12	2	6	8	14
5	7	13	40	11	1	3	9	15
6	3	5	44	13	6	18	4	7
7	1	2	38	11	3	9	8	14
8	4	7	24	7	6	18	3	5
9	1	2	24	7	1	3	5	9
10	4	7	22	6	1	3	3	5
11	1	2	11	3	0	0	0	0
12	2	4	4	1	2	6	0	0
13	2	4	7	2	1	3	0	0
14	1	2	3	1	0	0	0	0
15	1	2	3	1	0	0	0	0
16	0	0	1	.005	1	3	0	0
17	0	0	2	1	0	0	0	0
TOTALS	44	98	351	97.5	34	96	59	96

The kinsmen who occupy a common household, be it a nuclear or extended family residence, form the basic economic group in the Teotihuacan Valley. The family is the primary unit of both production and consumption. All agricultural lands are in effect controlled by it. This control is normally exercised by the head male. Two types of land ownership categories are found in the valley, propiedad particular or private land and propiedad ejidal or government-owned land. The former legally belong to the individual who holds the deed. They may be bought, sold, rented or transferred in any manner the owners deem desirable and are inherited by the children of the deceased owner. They may be used for any purpose the owner wishes.

Propiedad Ejidal, the second type, is owned by the federal government. A major form of landholding during the colonial period was communal ownership by Indian communities. The village holdings were divided up among the villagers so that each family could support itself. After Mexico gained its independence from Spain, the communal holdings lost their legal standing and most were incorporated into large haciendas. This process resulted in an acute land shortage and a source of cheap labor in the form of landless families. Although the Revolution of 1910 was primarily political in nature, at least at the beginning, land reform became one of the prime motivating forces behind it. A major result of the revolution was agrarian reform as embodied in the ejido program. The government confiscated many large landholdings and forced the partition of many others. The lands involved were returned to the villages although the federal government retained actual ownership. In the Teotihuacan Valley such lands were apportioned to villagers with little or no propiedad particular. The actual division of the land was determined by village councils. Today these councils consist of ejido landholders who are elected by their fellow landholders or ejiditarios.

Several regulations exist concerning the use of ejido land which do not apply to privately owned land. For example, land which is not cultivated for a period of two years is taken away from the landholder and given to someone else. Upon the death of a ejiditario, the land legally reverts to the council to be redistributed but in practice it is usually assigned to the children of the deceased holder. Ejido land may not be bought, sold, transferred or rented to another person. If the holder complies with the above regulations, he is almost certain to hold the land as long as he wants it. Several good summaries of the ejido program have been published, one of the best is found in Rural Mexico by Nathan Whetten (1948).

Questions 13 and 15 dealt with landholding. The responses to these questions were without doubt the most unreliable part of the questionnaire. Several factors account for this. People in the area are reluctant to discuss land ownership with anyone. There is widespread fear of increased property taxes. This has led to the universal practice of reporting less land than is actually held or denying land ownership entirely. Fear of government confiscation of land for the ejido program or for public works such as highways is also common. Furthermore, the people feel that foreigners doing research with government permission (as did the investigator) must also be working for the government and reporting back to it.

In light of this, the only reliable conclusion which can be drawn from the responses to questions 13 and 15 is the number of families who admitted

holding agricultural lands. This is a minimum number and percentage, the true count may be considerably higher.

Five hundred twenty responses were counted from the four communities, 208 households or 40 percent admitted to owning farm land or holding ejido land (Table 12). Considerable inter-community differences exist. Seventy-two percent of the Cuanalan households admitted to landholding; in San Juan Teotihuacan, 25 percent; in Santiago Tepetitlan, 87 percent and in Santa Maria Palapa, 71 percent (Table 13).

The males of the family form the basic agricultural work group. This aspect of life was not covered in the questionnaire and the following is based upon general observations made by the investigator during the fifteen months he has spent in the valley. Communal labor in the agricultural fields is conspicuously absent. There are no supra-familial organizations, formal or informal, upon which the Teotihuacano calls for agricultural labor. A man needing assistance prefers to hire helpers. Occasionally he will call upon a friend or a compadre but this is less common than the use of hired help. The only occasion on which large groups of unrelated men work together at agricultural tasks is during the annual cleaning of the canals and reparation of dams in the irrigated zone.

Just as the family is the most important land-using and agricultural production unit, it is also the primary consumption unit for agricultural produce. After crops are harvested and a certain portion sold for cash, the remainder is stored in the house until needed. The fact that every house in each of the four communities surveyed has a kitchen strengthens the assertion that the family is the unit of consumption. Most extended family residences have two or more kitchens, one for each nuclear family.

Table 12

Number and Percentage of Families Which Hold Farm Land in the Total Sample, Based on Questions Thirteen and Fifteen

	Number	Percentage
Own "Propiedad Particular" or hold "Propiedad Ejidal"	208	40
Do Not Hold Any Farm Land	312	60
	520 Total	100 Total

Table 13

Number and Percentage of Families Which Hold Farm Land
in Each of the Four Communities,
Based on Questions Thirteen and Fifteen

Community	Own "Propiedad Particular" or hold "Propiedad Ejidal"		Do Not Hold Any Farm Land	
	Number	Percent	Number	Percent
Cuanalan	48	72	19	28
San Juan Teotihuacan	91	25	272	75
Santiago Tepetitlan	27	87	4	13
Santa Maria Palapa	42	71	17	29

The sexual division of labor is well marked in some economic endeavors and almost absent in others. In agriculture, the males prepare the fields, plant, care for the crops, and do the harvesting. Female participation in such work is frowned upon. This feeling extends even to widows; if a widow owns farm land, the work will be done by either a male relative or a hired hand. Other strictly male occupations include house building, adobe making and care of cattle. The woman's sphere includes cooking, care of the house and children, collecting firewood and marketing. If the family owns a store or business, both husband and wife generally work there. The owners of smaller stores tend to live in the same building that houses the store, thus a woman can often do her housework while tending the store. Many specialized occupations are reserved for men; these include bartender, mechanic, truck driver, carpenter, electrician and blacksmith.

There is ample evidence that the family is a functional religious unit. Data on this subject was not included in the questionnaire and the following observations were made on an informal basis.

Every house that the investigator has entered in the Teotihuacan Valley has a small altar on a table or on a shelf on the wall. The objects placed on the altar always include a picture or statue of a saint and at least one candle. Flowers often form part of the offering. The altar is the focus of familial religious services several times during the year; these occasions include the patron saint's day of the community and November 2, the Day of the Dead. At these times, the altar offerings may include numerous candles, special tablecloths, foods, etc. As far as the investigator has been able to ascertain, however, there are no organized observances held in front of the altar; the main religious activity lies in its preparation. Worship tends to be informal and individual.

The Settlement Patterns of the Family

The following discussion is based upon observations by the investigator

and lacks quantifiable data. Early in the house-to-house survey, an attempt was made to sketch each houselot. This brought about a hostile reaction on the part of the householder on several occasions and was soon abandoned.

Individual houselots vary considerably in their size and complexity, but nearly all share certain features. Many have walls surrounding the lot; these are at least one meter high, generally higher. They are almost always made of adobe, stone or organ cactus. The walls delimit the residence area and living structures are never found outside the wall. The interior consists of a large, open patio. This generally has a well swept dirt floor though concrete floors are occasionally found. Most houselots have at least two buildings, a living structure and a kitchen. The living structure is generally the largest building in the compound and serves as a bedroom and a place in which to entertain guests. It invariably contains the family altar. The area under its roof is often used for grain storage. The kitchen is the most frequently used building in the complex. It contains a fire place or hearth and various culinary utensils. The walls around the hearth are generally smoke blackened. Here the food is prepared and often consumed. The kitchen also serves as sleeping quarters for children. A common pattern is for all the children of one sex to sleep in the kitchen while those of the opposite sex sleep with the parents in the living structure. If the household residence group is an extended family, there is always one kitchen for each nuclear family.

A house may have other buildings in addition to those already mentioned. These may include animal sheds, grain storage sheds and workshops.

Two basic types of houselots are found in the valley, the compact and the dispersed. A compact houselot has all the rooms under a continuous roof. They are generally placed along one side of the compound with their outer walls forming part of the houselot wall. The rooms are sometimes located on two adjacent walls and form an L but only rarely do they cover all four sides of the compound. Compact houselots tend to occur in communities with high population densities. One variant of this is restricted to urban communities and is particularly characteristic of the core or central portions of such settlements. This variant is characterized by a very high ratio of roofed-over space to open court. The core of San Juan Teotihuacan contains a series of such complexes attached wall to wall.

Dispersed houselots consist of several buildings placed at various points around the patio. Each has its own separate roof and is not connected to the other buildings. This type is the norm in rural settlements with low population densities, but also occurs on the peripheries of urban and high density rural communities. Such lots may or may not have enclosure walls.

Urbanism and Barrio Organization in San Juan Teotihuacan

The concept of urbanism is central to the following discussion. The Mexican government census defines an urban center as a community with more than 2500 inhabitants. (Octavo Censo General de Poblacion, 1960, p. 13). The author of the introduction to the 1960 census states that this definition does not take into consideration political and administrative standing, occupational specialization and similar characteristics.

One of the most useful definitions of urban is that provided by Wirth. "For sociological purposes, a city may be defined as a relatively large, dense and permanent settlement of socially heterogeneous individuals." (Wirth, 1964, p. 66). It should be noted that absolute number limits are not used in this definition, contrary to the usage of the Mexican census bureau.

In his discussion of population density, Wirth says, "As Darwin pointed out for flora and fauna and Durkheim noted in the case of human societies, an increase in numbers when the area is held constant tends to produce differentiation and specialization, since only in this way can the area support increased numbers." (Ibid, p. 73).

Wirth does not elaborate on residential permanency as a criterion for urbanism but it is apparent that he would consider non-permanent settlements to be urban such as army barracks and boom towns.

His concept of social heterogeneity involves ethnic, class, caste, occupational and wealth differences.

Wirth discusses several secondary phenomena characteristic of urban centers. Only two of these are important for this discussion. One is that urban dwellers are much more mobile than non-urbanites, and the other is that urban dwellers tend to be renters, not homeowners.

The previously mentioned traits of urban centers will play an important role in the following discussion. These traits are:

1. relatively large population
2. relatively high population density
3. a large degree of social heterogeneity
4. a high degree of spatial mobility
5. a high frequency of home rental

The term barrio refers to a community subdivision or ward. Not all Mexican communities are divided into barrios but compound communities of this type are found throughout the republic. At times barrios are physically conjoined, at other times, they are separated. These units are of unequal size and importance, and the variations among them are considerable. One barrio in each community always has a larger population or larger area than the others. They also differ in other characteristics.

Barrios are difficult to define on maps or on the ground. The four barrios of San Juan Teotihuacan which form the compound community are physically conjoined and their boundaries lack physical identification marks. When barrios are separated from the main community, it is impossible to differentiate a barrio community from a non-barrio in the same area.

San Juan Teotihuacan has five barrios; San Juan Evangelista, Purificacion, La Villa, Puxtla and Maquixco. The first four are physically conjoined, the fifth lies two kilometers to the west and is separate from the others. San Juan Evangelista lies on the western edge of town, north of the Mexico City-Teotihuacan highway. (Map 1). Its southern limit is the highway between it and the barrio of Puxtla. The eastern boundary is a small barranca which separates it from La Villa. The northern and western limits are agricultural

fields. It is located on a slight north to south grade. The total barrio population is 665 people. Seventy-one percent of the houses surveyed have adobe walls and fifty-one percent have a type of flat brick and mortar roof known locally as a techo de boveda. (Table 15). This barrio has electric service and only a few houses lack electricity. At the time of the study, there was no public water supply in the barrio, but since then a well has been dug and water is piped directly to the houses. The streets are relatively straight but the blocks they form are not truly rectangular. The streets and sidewalks are not paved.

The barrio of La Villa is centrally located in the community. Its eastern boundary is Purificacion; its western boundary abuts two barrios, Puxtla and San Juan Evangelista. The northern and southern limits are open fields. La Villa is located on flat ground. The total population is 2294 inhabitants. Some of the buildings in the barrio contain numerous one and two room apartments which are all part of one building complex. There are many non-residential structures, including stores, offices, restaurants, and other specialized buildings. Fifty-nine percent of the residences included in the house-to-house survey are of adobe and 64 percent have the previously mentioned brick roof. (Table 15). The streets are straight and generally form rectangular blocks, especially in the center of town. Most are not paved but many do have paved sidewalks. A large plaza is located approximately in the center of the barrio, it is surrounded by a school, the municipal palace and several stores. The church is located several blocks south of the plaza, directly over the springs which feed the lower valley irrigation system. Electrical service is available and is utilized by nearly everybody in La Villa. A public water supply is being installed at the present time.

Puxtla is located on the western edge of town, south of San Juan Evangelista. Its eastern boundary borders La Villa and the southern and western boundaries are open agricultural fields. It has the smallest population and area of the four barrios. The total population is 205 inhabitants. The few streets are straight but unpaved, the houses are widely spaced. Ninety-three percent of the houses surveyed are of adobe construction, and brick roofs account for only forty percent of the total. (Table 15). The barrio is located within the chinampa area, an area of numerous springs and moist soil. Many houses are placed on the chinampas, resulting in a very dispersed settlement pattern. Many of the crops grown in this barrio are cash crops (vegetables and flowers) and are sold in Mexico City. A small plaza in Puxtla faces an abandoned church and a store.

Purificacion is located east of La Villa, its other three boundaries are agricultural fields. It is the largest barrio in areal extent and the second largest in population (1373 inhabitants). The streets are straight but unpaved. The blocks near the center of the barrio are generally rectangular but the regularity disappears at the periphery. Much of the land within the barrio is used for subsistence agriculture. The barrio plaza is surrounded by the church, the primary school and several stores. Forty-eight of the residences surveyed are of adobe construction and 51 percent have boveda roofs. (Table 15). Electrical service is available and most houses are electrified. There is no public water supply.

The barrio does not play an important role in religion. Each barrio has a church but only two are presently open, those in La Villa and Purificacion.

TABLE 14

The Population and Number
of Residences in Each Barrio
Based upon the Mexican Census of 1960

	Population
San Juan Evangelista	665
Puxtla	205
La Villa	2294
Purificacion	1373

TABLE 15

Relative Percentages of Houses
With Brick Walls, Adobe Walls, and Brick Roofs (Boveda)
in Each of the Four Barrios,
Based on Question Eleven

	Brick Walls	Adobe Walls	Brick Roof (Boveda)
San Juan Evangelista	18	71	51
Purificacion	17	48	51
Puxtla	7	93	40
La Villa	31	59	64

TABLE 16

Number and Percentage of Adult Males Following Agricultural and Non-Agricultural Occupations in Each of the Four Barrios, Military Personnel Excluded

Barrio	Non-Agriculturalists		Agriculturalists	
	Number	Percent	Number	Percent
San Juan Evangelista	39	62	24	38
Purificacion	28	64	16	36
Puxtla	15	58	11	42
La Villa	127	99	2	1

TABLE 17

Number and Percentage of People Over Age Fifteen in Each Barrio Who Are Not Native to San Juan Teotihuacan, Military Personnel Excluded

	Number	Percent
San Juan Evangelista	36	14
Purificacion	13	7
Puxtla	12	12
La Villa	128	27

The others have been closed by the federal government. The two closed churches are opened once a year and a Mass is said but the Masses are poorly attended. The only barrio with an important Saint's Day fiesta is La Villa and this fiesta is celebrated by the entire community, not just the barrio. Barrio members are not obligated to work for the church or to contribute to its maintenance.

Barrios are listed in the federal census but they have no political functions; nor do they have status in the ejido program.

The barrio does serve an educational function in that three of the four barrios have schools. Puxtla, the smallest barrio, is the only one which lacks a school. La Villa, San Juan Evangelista and Purificacion all have public primary schools; La Villa also has a private primary school. La Villa contains the only high school in the community; its pupils come from all over the Teotihuacan Valley. Unfortunately, no data was gathered on the specific relationships of the barrios to the schools.

The barrios do not serve as a focus of integration for its members. Derrogatory nicknames are not used to designate particular barrios or their members. Changes of residence from one barrio to another are common and barrio endogamy is not consistent. People answering Question 8 (this question dealt with where the respondent would like to live) were not at all hesitant in preferring another barrio.

Barrio differences are quite pronounced in economics. Several questions in the survey are of value in defining barrio economic patterns. Question 5 concerned the occupation of the adult males in the household. Inter-barrio differences in percentages of males involved in non-agricultural pursuits is quite striking. Sixty-two percent of the adult males in San Juan Evangelista practice non-agricultural occupations; in Puxtla, 58 percent; in Purificacion, 64 percent and in La Villa, 99 percent (Table 16). These percentages include military personnel but the subtractions of these individuals would not affect significantly the results. Men with certain occupations were found in all barrios; these occupations include construction worker, store keeper, office worker and day laborer. Certain types of occupations were found only in the La Villa sample; these include mechanic, bus driver, baker, physician, wholesaler and professional politician.

The relative percentages of store keepers and businessmen in each barrio are of interest. Three percent of the non-military males in San Juan Evangelista were in this category; in Puxtla, 11 percent and in La Villa, 33 percent. Data is lacking for Purificacion because the unsurveyed portion of the barrio is the one which contains the majority of the business establishments. Although complete data is lacking, there is no doubt that La Villa is the leader in this category. This conclusion is reinforced by a comparison of the number of shops in each of the four barrios. There are four shops in San Juan Evangelista, one in Puxtla, five in Purificacion and seventy in La Villa.

One indication of the economic differences between La Villa and the other barrios is the prevalence of certain house construction materials. Brick construction is the most expensive of the commonly used types. The bricks themselves are more expensive than adobe or stone, they require a more expensive mortar and labor costs are considerably higher. People who cannot afford completely brick houses often settle for a brick (boveda) roof. Thus the percentage of brick houses in a barrio should provide an index of economic status of the barrio inhabitants relative to those of other barrios. Question 11 concerned the construction materials used in the walls and roof of the main building on the houselot. Eighteen percent of the San Juan Evangelista houses have brick walls and 51 percent have brick roofs. In Purificacion, 17 percent have brick walls and 51 percent have brick roofs. In Puxtla, 7 percent have brick walls and 40 percent have brick roofs. In La Villa, 31 percent have brick walls and 64 percent have brick roofs. This data is summarized in Table 15. These figures demonstrate that the most expensive construction material is most common in La Villa and that the La Villa inhabitants are economically better off than those of the other barrios.

The responses to Question 18 also show clear intra-barrio differences. This question dealt with home ownership versus home rental. Seventy percent of the people interviewed in San Juan Evangelista owned their own homes; in Purificacion, 76 percent, in Puxtla, 85 percent; but in La Villa, only 36 percent own their homes. Many renters are military personnel who are temporary residents and who have no reason to buy a house. When they are eliminated from the calculation, fifty-one percent of the non-military families in La Villa own their home instead of the 36 percent previously calculated. Not all renters are poor. Rented houses are often large and spacious, their occupants own automobiles, refrigerators and television sets and the family head has a well paid and prestigeful occupation. These people could be homeowners if they so desired. Perhaps variables such as the expectation of not remaining permanently in the community, desire for living at a particular location in the town and scarcity of suitable houses for sale account for the fact that such people rent. This type of renter and rented house are almost completely restricted to La Villa. The other extreme in rented houses is represented by small, cramped, one and two room apartments. These are rented by low income families whose head may be a soldier, a day laborer, a street vendor, etc. These people rent for a combination of two reasons; first, they are too poor to buy or build a house, second, they are relatively mobile and do not remain in one place for long periods of time.

In summary, the data on house ownership in the barrios shows La Villa to be the most urban of the four barrios.

Question 3 was asked to determine the number of non-natives in each community and barrio. Once again, marked differences exist among barrios. Military personnel were eliminated in all cases. In San Juan Evangelista, 36 persons over age fifteen were not native to San Juan Teotihuacan. They represent 14 percent of all people over age fifteen. In Purificacion, the number was 13, representing seven percent of the sample. In Puxtla, the number was 12, representing 12 percent of the sample. In La Villa, the number was 128, representing 27 percent of all people over age fifteen. This data is summarized in Table 17. The non-natives in San Juan Evangelista, Puxtla and Purificacion all come from states within the Central

Mexican Plateau or immediately adjacent to it. These include Tlaxcala, Hidalgo, Puebla, Morelos and Veracruz. The non-native inhabitants in La Villa come from the entire republic as well as from Spain and the United States. The largest single group of immigrants is made up of wives who have come to live with their husbands. Most non-military male immigrants practice white collar occupations (medical doctor, clerk, businessman, etc.) or have special skills (mechanic, electrician, baker, etc.).

The higher percentage of immigrants in La Villa reinforces the assertion that this barrio dominates the others economically. If this were not so, the immigration would not have occurred. The immigration has, in turn, reinforced this economic dominance.

The importance of its weekly market is another indication of the dominance of La Villa. This is the only market in the community and people come from all the barrios and nearby villages to do business. Market day is Monday but in recent years an increasing number of vendors arrive on Sunday and set up their stalls on Sunday afternoon. The products sold include basic food stuffs such as maize, beans, peppers and tomatoes; non-basic food such as fish, vegetables, fruits and condiments; cordage; pottery; baskets and mats; clothing; tools; bicycle parts; and multifarious household items. In addition, there is a smaller daily market which concentrates on food items and which is attended by people from all barrios. The daily market is housed in a special building in the center of La Villa. The weekly market uses this building as a nucleus but the vendors also occupy the streets and sidewalks surrounding it.

The appearance of La Villa differs strikingly from other barrios. It has many specialized services found only there; these include a telegraph office, a telephone office, the municipal palace, a private primary school, a post office, a government tax office, the army post, the only power and light company office in the valley and several restaurants. Though the buses from Mexico City pass through all the barrios, their only fixed stop is in La Villa.

The following conclusions may be drawn in summary. The barrio lacks strong religious and social connotations in San Juan Teotihuacan. The differences among barrios in the community are products of economic factors. The high incidence of home rental, the high percentage of non-natives and the economic specialization found in La Villa are all indicative of the comparative urbanity and high economic status of that barrio in relation to the others.

The Community in the Teotihuacan Valley - The Four Community Study

The term community is here defined as any local, geographically defined settlement the inhabitants of which live, work and interact together.

Four communities were included in the house-to-house survey; Cuanalan, San Juan Teotihuacan, Santiago Tepetitlan and Santa Maria Palapa.

Cuanalan is located on the Lower Valley plain. According to the 1960 census it has a population of 1544 inhabitants. Four hundred thirty-five individuals were included in the survey. The village is rectangular in shape. (Map 2) The village church, a building which dates back to the nineteenth century lies near the center of the long axis. The two building

public primary school is behind the church. One is an old, run-down, two room structure built around 1900, the other is a modern six-room building. Cuanalan is not a cabecera, thus it does not have a municipal government building. The panteon or graveyard is at one edge of the community. The church courtyard was formerly used as a graveyard. The sole industry in the community is a factory which processes crude building stone for construction in Mexico City. The community has electricity and most houses receive service. There is no public water supply or sewage disposal. The streets are unpaved. Four to six buses service the community daily.

San Juan Teotihuacan and its component barrios have been described previously and further comments are not needed. The combined populations of the four barrios in the 1960 census was 4537 people.

Santiago Tepetitlan is located on the flanks of the Patlachique mountain range. The 1960 census lists the population as 536 people. The church is at the northern edge of the community. (Map 3). It was closed some years ago by the federal government and is in disrepair. An old two room building near the church is used as a school. There is no permanent teacher and classes are taught by soldiers from San Juan Teotihuacan. The houses of the community are located on terraces constructed on a spur of the Patlachique range. The paths that connect the houses are not straight but tend to follow the microtopography of the area. The houses are well spaced and each is surrounded by a maize or nopal garden. The buildings in the center of the community are less widely separated than are those on the peripheries. A bus enters the community every two or three days. An unpaved, all-weather road provides access to the community. There is no electricity, public water supply or industry.

Santa Maria Palapa is located across the valley from Santiago Teptetitlan. The 1960 census lists its population as 388 people. The local church is closed except for one or two days a year. The one room school lacks a permanent teacher and classes are taught by soldiers from San Juan Teotihuacan. The church and school are located on a plaza which the inhabitants conceive of as the social center of the community (Map 4). The houses are very widely dispersed on the flanks of the mountain Cerro Gordo, and there is no noticeable clustering near the plaza. The community lacks streets, with the exception of the barranca which leads down to the main highway. The only vehicle that regularly enters the community is a Jeep which brings the soldier-teachers. There is no electricity, public water supply or industry.

The four communities will now be compared in terms of their degree of urbanism. Population size is the first criterion. San Juan Teotihuacan is the most populous of the four communities since it has 4537 inhabitants. It is the only one of the four classified as urban in the 1960 census. Cuanalan is second in population with 1541 inhabitants, followed by Santiago Tepetitlan with 536 and Santa Maria Palapa with 388. This data is summarized in Table 18.

Population density is the second criterion of urbanism. The areal extent of each community was calculated utilizing amplifications of aerial photographs. The population figures were taken from the 1960 census and the population density of each community was calculated. San Juan Teotihuacan has the highest density, 2563 people per sq. km. Cuanalan has a density of 2342 per sq. km., Santiago Tepetitlan is third with 2036 per sq. km. and Santa Maria Palapa is

TABLE 18

Total Populations and Population Densities Per Square Kilometer of the Four Communities

Community	Total Population	Population Density
Cuanalan	1541	2342
San Juan Teotihuacan	4537	2563
Santiago Tepetitlan	536	2036
Santa Maria Palapa	388	423

TABLE 19

Percentages of Houses Built of Differing Construction Materials in the Four Communities

Community	Stone	Adobe	Brick	Misc.
Cuanalan	0	90	10	0
San Juan Teotihuacan	13	62	24	1
Santiago Tepetitlan	41	23	3	33
Santa Maria Palapa	86	5	3	6

TABLE 20

Average Number of People
Per Household in the Four Communities,
Based on Question One

Community	Number Per Household
Cuanalan	5.8
San Juan Teotihuacan	6.0
Santiago Tepetitlan	4.9
Santa Maria Palapa	5.1

TABLE 21

Percentages of Nuclear Family
Residences in the Four Communities,
Based on Question Six

Community	Percentage
Cuanalan	64
San Juan Teotihuacan	67
Santiago Tepetitlan	71
Santa Maria Palapa	81

TABLE 22

Percentages of Males Involved
in Non-Agricultural Occupations
in Each of the Four Communities
Based on Question Five

Community	Percentage
Cuanalan	35
San Juan Teotihuacan	76
Santiago Tepetitlan	25
Santa Maria Palapa	4

TABLE 23

Percentage of Non-Natives
Over the Age of Fifteen
in Each of the Four Communities,
Based on Question Three

Community	Percentage
Cuanalan	7
San Juan Teotihuacan	19
Santiago Tepetitlan	3
Santa Maria Palapa	1

the least dense with 423 per sq km These figures are summarized in Table 18. The rank order of the population density agrees with that of the population size, that is, the community with the highest population density also has the highest population and so on These indices demonstrate that San Juan Teotihuacan is the most urban of the four communities, followed by Cuanalan, Santiago Tepetitlan and Santa Maria Palapa, in that order.

Wirth's third criterion of urbanism is social heterogeneity Several indicators of this have been selected from the house-to-house survey. They include house types, residence patterns, occupational specialization, residential mobility, home ownership patterns, and availability of certain services.

The first of these is house type. Notable differences exist among the communities with respect to house construction materials. Ninety percent of the houses surveyed in Cuanalan have adobe walls, and the other ten percent are of brick. The most popular single roof type is the boveda or brick roof, found in 46 percent of the houses surveyed. The prevalence of adobe construction may be explained by a combination of factors. Its lower cost relative to brick seems to be the most important one. Also there is an excellent supply of good adobe making clay near the village and a lack of construction stone. In San Juan Teotihuacan, houses of adobe construction make up 62 percent of the total, those of stone 13 percent, and those of brick 24 percent. The most popular roof type is boveda; found in 57 percent of the total. These figures can, with one exception, be explained in the same terms as those of Cuanalan. The stone structures are found for the most part in the area located on the remains of the archaeological zone, where building stone debris is plentiful.

The house types of Santiago Tepetitlan present a problem of classification. Some structures (33 percent of the total) have walls with high stone bases topped by adobe bricks. The stone bases often make up more than half of the wall height and it is difficult to classify the houses as stone or adobe. Twenty-three percent of the structures are built completely of adobe and 41 percent completely of stone; only three percent are brick Good construction stone is plentiful in the area, as is good adobe earth. The most popular roof type is the Spanish tile or teja, found on 62 percent of the houses.

Eighty-six percent of the buildings in Santa Maria Palapa are of stone, only five percent are of adobe and three percent of brick Stone is plentiful in the area and local informants say a stone house is less costly than one of adobe. The most popular roofing material is teja; it accounts for 61 percent of the total Table 19 summarizes the above data.

The relative percentage of brick houses in each community is indicative of the economic status of the community members. The percentages are: Cuanalan - 10 percent, San Juan Teotihuacan - 24 percent, and three percent in both Santiago Tepetitlan and Santa Maria Palapa

The average number of inhabitants per household was calculated for each community. The total number of people in the sample was divided by the total number of households The Cuanalan average was 5 8 per household. In San Juan Teotihuacan, it was 6.0 per household. In Santiago Tepetitlan, it was 4.9 per household and in Santa Maria Palapa, 5.1. (Table 20). San Juan Teotihuacan has the highest average, this is probably a reflection of the

greater crowding which occurs in an urban setting.

Noticeable differences exist in the percentage of nuclear family residences in the four communities. In Cuanalan, nuclear family residences account for 64 percent of the total sample; in San Juan Teotihuacan 67 percent; in Santiago Tepetitlan, 71 percent and in Santa Maria Palapa, 81 percent (Table 21). The two communities with the lowest percentages of nuclear family residences and conversely the highest percentages of extended families are Cuanalan and San Juan Teotihuacan. These same communities have the highest average number of people per household and the highest percentages of brick homes.

There are striking differences in occupational specialization among the four communities. Thirty-five percent of the adult male population in Cuanalan practice non-agricultural occupations. The principal occupations are store keeper and day laborer. Seventy-six percent of the adult males in San Juan Teotihuacan practice non-agricultural occupations. These include store keeper, office worker, mechanic, barber, butcher, building trade specialist and day laborer. Military personnel were excluded from the tabulation. In Santiago Tepetitlan, 25 percent of the adult males are non-agriculturalists; all are day laborers. In Santa Maria Palapa, only four percent are non-agriculturalists; all are day laborers. This data is summarized in Table 22.

Two facts are worthy of mention in this comparison. First, a higher percentage of the inhabitants of San Juan Teotihuacan are non-agriculturalists than is true of the other communities; second, the range of economic activities is much greater in San Juan Teotihuacan than in other communities.

The relative percentage of store keepers in each community was calculated. Twenty-one percent of the adult male population of San Juan Teotihuacan are involved in this occupation; in Cuanalan, it is 12 percent. There are no store keepers in Santiago Tepetitlan or Santa Maria Palapa.

A calculation was made of the percentage of non-natives over the age of fifteen in each community. In Cuanalan, 7 percent of the population fit into this category. In San Juan Teotihuacan it was 19 percent, excluding military personnel. In Santiago Tepetitlan, it was 3 percent and in Santa Maria Palapa, 1 percent. The data is summarized in Table 23. The non-natives in Cuanalan, Santiago Tepetitlan and Santa Maria Palapa were without exception drawn from states which border the State of Mexico. Those in San Juan Teotihuacan come from all over the Republic.

In an attempt to verify Wirth's assertion that people in urban centers have a tendency to rent homes rather than own them, a calculation was made of the relative percentages of home owners and renters in the four communities. The question dealing with home ownership was not put into the questionnaire until after Cuanalan was surveyed, so data is lacking for that community. In San Juan Teotihuacan, 37 percent of the households occupy rented homes. In Santiago Tepetitlan, only four percent rent and in Santa Maria Palapa, only five percent. The following are all possible explanations for the higher percentage of renters in San Juan Teotihuacan. A significant portion of the population is not native to the community, automatically eliminating the possibility of inheriting a house. Many non-natives do not plan to remain

in the community permanently and do not want the expense and trouble of buying a house. There is a scarcity of suitable houselots and structures for sale. This is particularly true of the better residences and of those in the desirable section of town. Another factor is that the majority of the people are non-agriculturalists and the value of owning property and/or a house is not as important to them as it might be among agriculturalists. The construction of an acceptable house in Santiago Tepetitlan and Santa Maria Palapa is not as expensive as in San Juan Teotihuacan because a house which is acceptable in these communities is much less elaborate than an acceptable one in San Juan Teotihuacan. Building materials are found nearby and the types of construction prevalent in these two communities are simple enough that a non-professional can do the majority of the work.

The differences in degree of urbanism among the four communities are noticeable in many aspects of communal life. The presence of government facilities is one. The only government buildings in Cuanalan are the church and school. There is also a post-office which consists of a letter drop box in a store. San Juan Teotihuacan has numerous government buildings; they include the municipal palace, a telegraph office, a telephone office, a tax collecting office, a town market, the headquarters of the electric company, the army barracks and several other buildings. Santiago Tepetitlan and Santa Maria Palapa both have a school and a church but no other government buildings.

There are also striking differences in the availability of services. San Juan Teotihuacan has barbers, mechanics, gas stations, restaurants, hotels, large grocery stores, clothing stores, furniture stores, dying and cleaning establishments, butchers, jewelers, medical doctors, lawyers and prostitutes, just to mention a few. None of these services are available in the other three communities.

In summary, the four communities exhibit differences in population size, population density and social heterogeneity. San Juan Teotihuacan is by far the most urban of the four, followed in order of decreasing urbanity by Cuanalan, Santiago Tepetitlan and Santa Maria Palapa.

The Community in the Valley - The General Survey

The methodology used in the general survey of communities in the valley has already been discussed. The data on total population, population density and social heterogeneity will be presented and the communities will be placed on an urban-rural continuum similar to that already done with the communities covered in the house-to-house survey.

Many types of data gathered in the house-to-house survey were not gathered in the general survey of communities. These include quantifiable data on house construction materials, percentage of non-natives, home ownerhsip patterns and occupational specialization. An attempt was made to gather data on occupational specialization through a count of specialized buildings such as stores and work shops in each community. This will be used in conjunction with population data from the 1960 census and the population densities calculated by the author.

Atlatongo

Location - The Lower Valley Irrigated Plain
Population - 1145
Population Density - 4850 per sq. km.
House Types - Most houses are of adobe
Specialized Buildings - There is a church, a primary school, nine general stores, and a bicycle repair shop.
Public Utilities - There is electricity but no public water supply.
Communication - The Mexico City-Teotihuacan highway passes through Atlatongo.
Political Status - Atlatongo is a pueblo in the municipio of Teotihuacan.
General Remarks - Dairying is an important agricultural specialization.

Axapusco

Location - The northern edge of the Upper Valley
Population - 1010
Population Density - 2020 per sq. km.
House Types - Stone, brick, and adobe are used in house construction.
Specialized Buildings - They include 4 general stores, one molino de nixtamal or corn grinding establishment, a municipal government building, a church, a public primary school, a Catholic primary school, a seminary, and a combination pulque brewery and research laboratory owned by the federal government.
Public Utilities - There is electricity and a public water supply.
Communications - There is a dirt, all-weather road to Otumba which connects with Mexico City and bus service to that city is quite good.
Political Status - It is the cabecera of the municipio of Axapusco.
General Remarks - The Axapusco church is quite elaborate, it is said to be one of the most ornate churches in the Republic. It lacks a weekly market, probably because of its nearness to the major market at Otumba.

Belen

Location - The southern piedmont strip of the Middle Valley.
Population - 988
Population Density - 2232 per sq. km.
House Types - Most of the houses are of stone but some adobe and brick are used.
Specialized Buildings - There is a church, a multi-room school, and four general stores.
Public Utilities - There is electricity but no public water supply.
Communication - A dirt, all-weather road connects with the Teotihuacan-Otumba highway and one bus a day comes to Belen.
Political Status - It is a pueblo in the municipio of Otumba.
General Remarks - The main cash crop of the community is the fruit of the nopal plant. The nopales are planted in orchards around the houses, resulting in the dispersion of the houselots over the landscape.

El Calvario Acolman

Location - On a low elevation within the Lower Valley Plain
Population - 1062
Population Density - 7805 per sq. km.

House Types - Most of the houses are of adobe construction but a few are brick.
Specialized Buildings - There is a church, a primary school, an office building for a national political party, a municipal government building, and twelve stores.
Public Utilities - There is electricity and a public water supply.
Communications - The Mexico City-Teotihuacan highway passes through the community.
Political Status - It is the cabecera of the municipio of Acolman.
General Remarks - El Calvario Acolman has the highest population density of any community in the survey and one of the highest in the valley.

Maquixco Bajo

Location - The edge of the Lower Valley Plain.
Population - 673
Population Density - 4206 per sq. km.
House Types - Adobe is the most common material but brick is used occasionally.
Specialized Buildings - They include a church, a primary school, four general stores, a beer distributing agency, and a tailor shop.
Public Utilities - There is electricity but no public water supply.
Communications - It lies on the Mexico City-Teotihuacan highway and bus service to both communities is good.
Political Status - It is a physically detached barrio of San Juan Teotihuacan.
General Remarks - The community comprises a line of houses on each side of the highway. It is 800 to 1000 meters long and 80 meters wide. Poultry raising is one of the agricultural specializations of the community, there are at least 5 granjas or poultry farms.

Otumba

Location - The Upper Valley Plain
Population - 1919
Population Density - 3204 per sq. km.
House Types - The materials used include stone, adobe, and brick.
Specialized Buildings - They include a large church, a public primary school, a telegraph office, a state police barracks, drug stores, general stores, bar rooms, restaurants, butcher shops, doctors' offices, a newspaper stand, an automobile parts store, a pool room, blacksmith shops, and molinos de nixtamal.
Public Utilities - There is electricity and a public water supply.
Communications - Otumba lies on the highway to Mexico City and is the terminal for the majority of the buses from that city.
Political Status - It is the cabecera of the municipio of Otumba.
General Remarks - A large weekly market is held in the plaza, it draws patrons from all the nearby communities, including Axapusco.

San Francisco Mazapan

Location - The Middle Valley Plain, physically joined to San Martin de las Piramides.
Population - 1143
Population Density - 2000 per sq. km.
House Types - Brick, adobe, and stone are all used in house construction.
Specialized Buildings - They include a church, two primary schools, a brick factory, a restaurant, and eleven general stores.

Public Utilities - There is electricity and a public water supply.
Communications - It is located on the Teotihuacan-Mexico City highway and buses to Mexico City pass through every fifteen minutes.
Political Status - It is a pueblo in the municipio of Teotihuacan.
General Remarks - Although it shares a border with San Martin de las Piramides, it is politically dependent upon San Juan Teotihuacan.

San Martin de las Piramides

Location - The Middle Valley Plain
Population - 3197
Population Density - 3996 per sq. km.
House Types - Stone, adobe, and brick are used in house construction.
Specialized Buildings - They include a church, a ten-room school, a new municipal government building, a telegraph office, a post office, and twenty-eight business establishments.
Public Utilities - There is electricity and a public water supply.
Communications - The community is situated on the road from San Juan Teotihuacan to Otumba and buses going to Mexico City pass through every fifteen minutes.
Political Status - It is the cabecera of the municipio of San Martin de las Piramides.
General Remarks - There is a weekly market in the community

Santa Catarina Acolman

Location - A low elevation on the edge of the Lower Valley Plain.
Population - 592
Population Density - 4250 per sq. km.
House Types - Most buildings are of adobe.
Specialized Buildings - There is a church, two primary schools, two small general stores, a barber shop, and a molino de nixtamal.
Public Utilities - There is electricity but no public water supply.
Communications - The Mexico City-Teotihuacan highway passes through the edge of the community and bus service is good.
Political Status - It is a pueblo in the municipio of Acolman.
General Remarks - The dairy industry is an important source of cash income in the community. Most families own at least a few head of cattle.

Zacualuca

Location - The north piedmont of the Lower Valley on the flanks of Cerro Zacualuca.
Population - 261
Population Density - 1132 per sq. km.
House Types - The majority of the houses are of adobe.
Specialized Buildings - There is a church, a three-room school, and one general store.
Public Utilities - There is no electricity or public water supply.
Communications - There is no road to Zacualuca.
Political Status - It is a pueblo in the municipio of Teotihuacan.
General Remarks - This community has the second lowest population density of all communities surveyed. This is due to the nopal orchards in the houselots which increase the houselot size and spread the houses further apart.

TABLE 24

Total Populations and Population Densities Per Square Kilometer of the Fourteen Communities

Community	Total Population	Population Density
Atlatongo	1145	4850
Axapusco	1010	2020
Belen	988	2232
Cuanalan	1541	2342
El Cavario Acolman	1062	7805
Maquixco	673	4206
Otumba	1919	3204
San Francisco Mazapa	1143	2000
San Martin de las Piramides	3197	3996
San Juan Teotihuacan	4357	2563
Santa Catarina Acolman	592	4250
Santa Maria Palapa	388	423
Santiago Tepetitlan	536	2036
Zacualuca	261	1132

TABLE 25

Rank Order and Classification
of the Fourteen Communities
According to Total Population

Rank	
	High Total Population
1	San Juan Teotihuacan
2	San Martin de las Piramides
3	Otumba
4	Cuanalan
	Moderate Total Population
5	Atlatongo
6	San Francisco Mazapa
7	El Calvario Acolman
8	Axapusco
9	Belen
	Low Total Population
10	Maquixco
11	Santa Catarina Acolman
12	Santiago Tepetitlan
13	Santa Maria Palapa
14	Zacualuca

TABLE 26

Rank Order and Classification
of the Fourteen Communities
According to Population Density

Community	Rank	Classification
Atlatongo	2	High Population Density
Axapusco	11	Moderate Population Density
Belen	9	Moderate Population Density
Cuanalan	8	Moderate Population Density
El Calvario Acolman	1	High Population Density
Maquixco	4	High Population Density
Otumba	6	High Population Density
San Francisco Mazapa	12	Moderate Population Density
San Martin de las Piramides	5	High Population Density
San Juan Teotihuacan	7	Moderate Population Density
Santa Catarina Acolman	3	High Population Density
Santa Maria Palapa	14	Low Population Density
Santiago Tepetitlan	10	Moderate Population Density
Zacualuca	13	Low Population Density

TABLE 27

Rank Order and Classification
of the Fourteen Communities
According to the Number of Specialized Buildings
Per Thousand Inhabitants

Community	Rank	Classification
Atlatongo	7	Moderate
Axapusco	4	Moderate
Belen	12	Low
Cuanalan	14	Low
El Calvario Acolman	3	High
Maquixco	11	Low
Otumba	1	High
San Francisco Mazapa	6	Moderate
San Martin de las Piramides	9	Moderate
San Juan Teotihuacan	2	High
Santa Catarina Acolman	8	Moderate
Santa Maria Palapa	10	Moderate
Santiago Tepetitlan	13	Low
Zacualuca	5	Moderate

Table 24 summarizes the total populations and population densities of the fourteen communities. Table 25 shows the rank order of the communities in the two categories. As can be readily seen, there is no simple correlation between population numbers and density. El Calvario Acolman ranks first in density but seventh in total population. Santa Catarina Acolman ranks third in density and eleventh in total population. The only agreement is at the lower end of the scale. Zacualuca is thirteenth in density and fourteenth in total population. Santa Maria Palapa is fourteenth in density and thirteenth in total population. The only community which ranks the same in both categories is Belen.

The communities were classified into three categories of total population and three of population density. The break-off points are the largest gaps in the rank orders. The resulting categories have been labelled high total population, moderate total population, and low total population; high density, moderate density, and low density.

The lower limit of the high total population category is 1541 inhabitants, that of the moderate total population category is 988 and the upper limit of the low total population category is 663 inhabitants. The communities in the high total population category are San Juan Teotihuacan, San Martin de las Piramides, Otumba, and Cuanalan. The moderate total population includes Atlatongo, San Francisco Mazapan, El Calvario Acolman, Axapusco, and Belen. Those in the low total population category are Maquixco, Santa Catarina Acolman, Santiago Tepetitlan, Santa Maria Palapa and Zacualuca (Table 25).

The lower limit of the high population density category is 3204 people per sq. km., the lower limit of the moderate density category is 2000 per sq. km. and the upper limit of the low density category is 1132 per sq. km. The high density communities include El Calvario Acolman, Atlatongo, Santa Catarina Acolman, Maquixco, San Martin de las Piramides and Otumba. Those in the moderate density category include San Juan Teotihuacan, Cuanalan, Belen, Santiago Tepetitlan, Axapusco, and San Francisco Mazapan. Those in the low density category are Zacualuca and Santa Maria Palapa (Table 26).

An attempt was made to quantify the available data on economic specialization. The number of specialized buildings per thousand inhabitants in the fourteen communities was calculated. Churches, schools, business establishments, and work shops were included in the count. The resultant rank order is presented in Table 27. The range is from 30 specialized buildings per thousand for Otumba to three per thousand for Cuanalan. The communities were classified into three categories based upon this calculation; high, moderate, and low economic specialization. The lower limit of the high category is 15 specialized buildings per thousand inhabitants, the lower limit of the moderate category is eight per thousand and the upper limit of the low category is six per thousand.

The communities in the high category are Otumba, San Juan Teotihuacan and El Calvario Acolman. Those in the moderate category are Axapusco, Zacualuca, San Francisco Mazapan, Atlatongo, Santa Catarina Acolman, San Martin de las Piramides and Santa Maria Palapa. Those in the low category are Maquixco, Belen, Santiago Tepetitlan, and Cuanalan.

As previously stated, the Mexican census bureau defines as urban communities those with more than 2500 inhabitants. According to this definition, only

two of the communities surveyed are urban, San Juan Teotihuacan and San Martin de las Piramides. Neither ranked high in all three categories. San Juan Teotihuacan placed high in total population and occupational specialization but not in population density; San Martin de las Piramides placed high in total population and population density but not in economic specialization. Otumba placed high in all three categories yet its total population is only 1919. El Calvario Acolman placed high in economic specialization and population density but its total population is only 1062. On the basis of the above measures and his own experience, the investigator concludes that San Juan Teotihuacan, San Martin de las Piramides, and Otumba are urban and that El Calvario Acolman is neither urban nor rural but intermediate. There would be no difficulty in considering El Calvario Acolman urban if its total population were double its present size.

La Villa is by far the most urban barrio in Teotihuacan. Were it an independent community, it would be the most urban community in the valley. It has a total population of 2294, larger than that of any community in the sample except for San Martin de las Piramides and its population density of 5735 people per sq. km. is exceeded only by El Calvario Acolman. It has 35 specialized buildings per thousand inhabitants, more than any of the fourteen communities. These three indices make it the most urban community in the valley. It can be argued that La Villa is not an independent community in the sense that El Calvario Acolman or Otumba are communities but since its population is comparable with those of the other communities and its functions are much the same, the comparison is both valid and enlightening. The significantly lower rating of San Juan Teotihuacan as a whole in population density and degree of social heterogeneity compared to La Villa above is due to the inclusion of the essentially rural settlements of Puxtla, San Juan Evangelista and Purificacion. They constitute 66 percent of the land surface of the community but contain only 33 percent of the population and less than 10 percent of the specialized buildings.

Zonal Settlement Patterns

The discussion thus far has focused on community settlement patterns and typology. We will now turn to a discussion of zonal patterns, i.e., the distribution and interrelationships of communities in the survey area.

We have previously noted the demographic significance of the Lower Valley-Delta area. It is difficult to convert areal measurements and population figures from the censuses (which are based on political divisions) to natural divisions of the valley but the following chart is probably reasonably accurate. The Lower Valley-Delta figure is based on the total of the municipios of Acolman (all), Atenco (the two villages within the survey area), Teotihuacan (about half the area and population), Tezoyuca (all) and Ecatepec (a small area around the village of Chiconautla). The Middle Valley figures refer to the municipios of San Martin (all), Teotihuacan (about half the population and area), Otumba (the villages of Santiago Tolman, Belen and Oxtotipac). The Upper Valley includes the remainder of Otumba, Axapusco (all of the portion within the valley) and Nopaltepec (all of the portion within the valley). The small portion of Temascalapa included in our survey is labeled the North Slope. All figures are rounded off approximations.

Ecological Area	Area (Km^2)	Population	Density per Km^2
Upper Valley	300	17,000	57
Middle Valley	150	14,000	93
Lower Valley - Delta	150	25,000	170
North Slope	50	1,500	30

Another indication of the demographic weighting towards the Lower Valley is seen in the location of political centers. Three of the municipal cabeceras are located in the Lower Valley-Delta (Acolman, Atenco, Tezoyuca); one on the west shore of Lake Texcoco outside this survey area near the old lake shore (Ecatepec); one at the head of the irrigation system where the Lower Valley begins--the most urban and largest community (San Juan); one in the Middle Valley within the alluvial plain (San Martin); and three in the Upper Valley, one in the deep soil plain (Otumba), another on the piedmont (Axapusco), and the other on the periphery of the piedmont-hill juncture (Nopaltepec).

Villages in the Delta occur on the old lake shore (Tequisistlan, Iztapan, Nexquipaya), on the flank of Cerro Chiconautla at the edge of the plain (Totolcingo, Chiconautla, Tepexpan-Chimalpa) or on the flank of an isolated hill (Tezoyuca).

Three strings of settlements are found in the Lower Valley, one along the west piedmont, another along the east piedmont (in both cases on the edge of the alluvial plain) and a third consisting of a string running down the center of the plain.

Santa Catarina Acolman-Tenango, Tecalco, Maquixco and the barrio of San Juan Evangelista are located along the west piedmont. Cuanalan-Zocango, Chipiltepec, San Pedro Tepetitlan, Xometla and San Lorenzo are located on the east piedmont. The central strip includes Calvario Acolman, San Bartolo-San Juanico, Santa Maria Acolman and Atlatongo. The first is situated on a low, natural elevation in the plain; Atlatongo is just within the plain, but near its edge.

The major factors which determine site location in the Delta or Lower Valley seem to be a combination of ecological and historic (which ultimately derive from the ecological factors). Premium agricultural lands such as the irrigated plain are rarely used for residence and the tendency is to locate villages in the poorer areas located nearby.

The position on the plain's edge places the farmer as close to the good agricultural land as possible, also locates him conveniently close to his fields on the piedmont and pasture land on the hilly flanks. Village holdings tend to crosscut all these ecological components except those located in the center which possess mostly irrigated plain. The narrowness of the alluvial plain (three to four kilometers means that lands are readily available to a population residing in either a continuous linear strip on each side (which would seem to be the most convenient arrangement) or a series of small, regularly spaced, compact villages (the present pattern).

The cluster of villages on the lake shore is the product of historical tradition. The pattern relates to an earlier period when these communities

specialized in salt manufacturing and extraction of other lake products. Villages on the north piedmont are aligned along the modern highway which closely approximates the position of the colonial Camino Real and probably the old Aztec route through the valley. Whether Aztec villages were built along older trade routes or the trade routes followed village distribution may be argued, but such routes once established would certainly operate as a stabilizing factor in community location. The fact that the villages within the plain lack or have very little piedmont-hillside land is probably the primary factor in their location within it. One exception is Atlatongo which does possess a sizable holding on the piedmont. The primary factor here may be the presence of the canal with the special privilege of a constant flow of water for village use. Most of the irrigation villages do obtain much of their household water supply from the canal system.

The location of the largest and most urban town, with the biggest market, midway down the valley, and near the springs reflects certain ecological factors. As shall be demonstrated in later reports in this series, the control of the springs has been a constant factor in the power structure of the valley for at least 600 years and probably 2000.

All the communities located within and along the edge of the alluvial plain, and they include all but a few, have population densities at the upper edge of the range.

The same basic principle of distribution applies in the Middle Valley. San Lucas, Santiago Tepetitlan, Belen, Tolman, Oxtotipac and Cuahutlacingo are all located outside the alluvial plain either on isolated hills or on the piedmont. In this area, however, the communities are located at the upper edge of the piedmont where it joins the steep slopes of Cerro Gordo and Patlachique Range rather than on the lower edge near the alluvial plain. Two factors seem to be operating here. First, the alluvial plain is much smaller, and the piedmont more extensive with many small, irrigable flood plains so that the former is a less significant element in village economy. Second, the serious water supply problem in this area is resolved by the construction of "jagueys", large artificial pits dug into the tepetate often to depths of three to 10 m. Water is diverted from the barrancas and stored in the jaguey throughout the year. Since they are uncovered and some water loss occurs through the tepetate, they are dug deeply and a large supply of water is needed. Best locations for jagueys would therefore seem to be at the upper edge of the piedmont to catch runoff before it dissipates into the deep barranca beds. Most communities in the Middle Valley in the piedmont area fall in Sanders' low density compact village or scattered village category. Two settlements, San Martin and San Pablo Isquitlan have high densities, the former because of its semi-urban status, the latter possibly related to its location within the alluvial plain. Several rancherias are also found in the dry northern tributary valley of this sector.

Most of the small settlements in the valley are located in the Upper Valley, particularly ranchos, rancherias and haciendas. The few villages in the area tend to be scattered or low density compact communities.

The Upper Valley town of Otumba is located in an unusual setting, the center of the deeper soil plain. Actually the plain is so small here that it is not a major ecological factor. The archaeological data suggest that

Otumba's location is of Spanish origin (as Gibson points out, the Spanish administration was decidedly nonecological in orientation--1954, pp. 5-8). A major problem produced by the selection of the Colonial site was that of water supply. It was met by the construction of a very impressive aqueduct bringing water from Cempoalla, located outside our survey area. Nearly all the other communities are located in positions similar to that in the Middle Valley, a ring around the upper edge of the wide piedmont strip, at the base of isolated hills to the north and the main range to the south.

No villages exist today in the Patlachique Range, a reflection of its marginal agricultural value.

Three villages in the North Slope-Cerro Gordo area are included within our survey. Two of them, Maquixco Alto and Colhuacan are located on terrace systems on the lower flank of the hill and are the subject of intensive analysis by Charlton in the succeeding paper. Teacalco is located at the base of the hill on the floor of a dry tributary valley. All have densities in the middle range, fitting into the category of compact low density villages in Sanders' classification.

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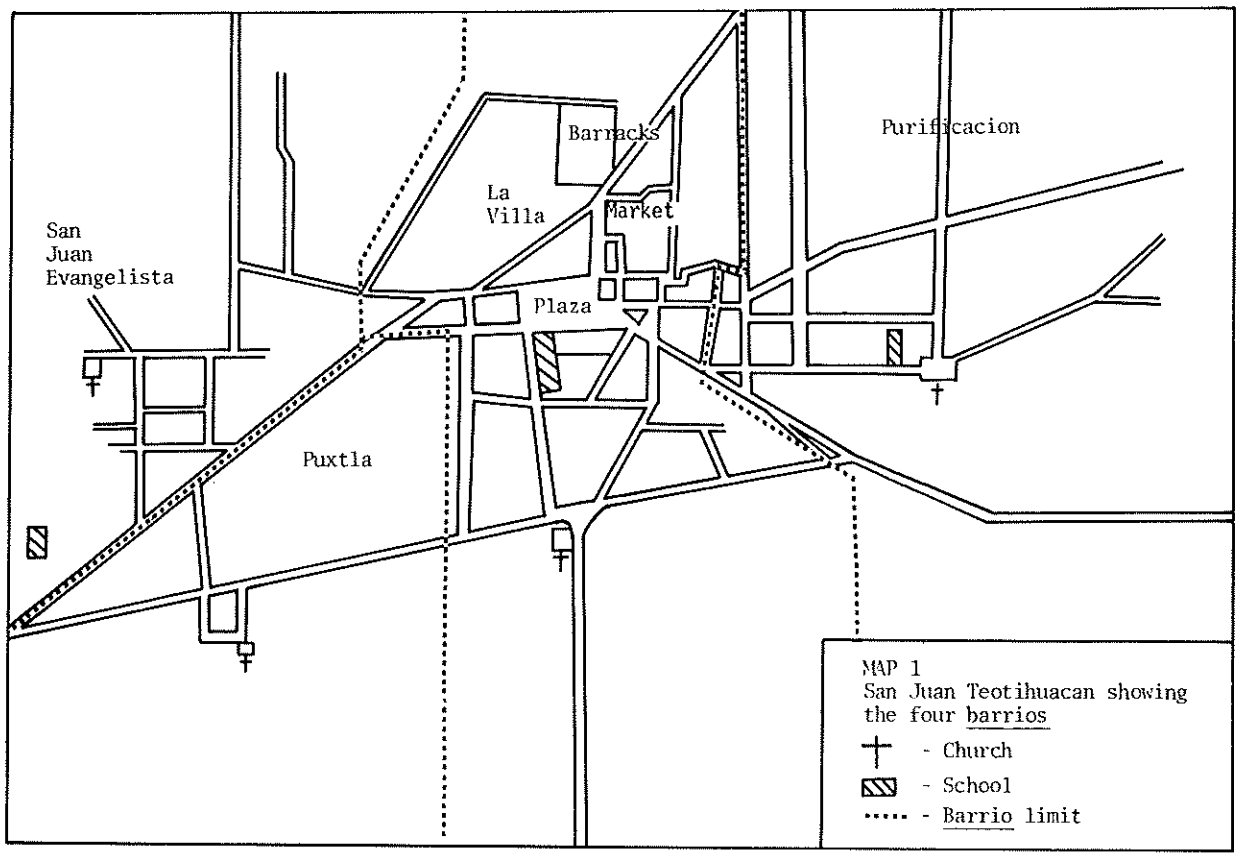
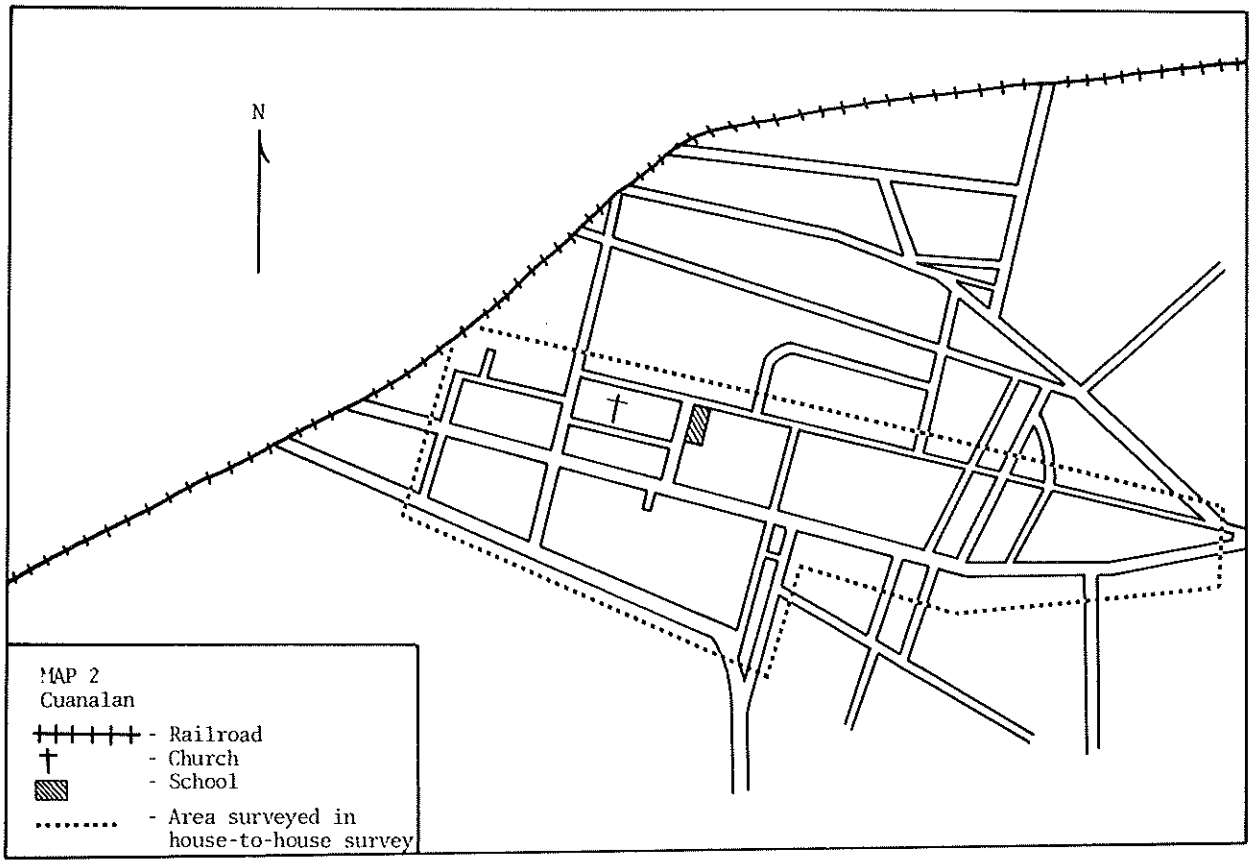
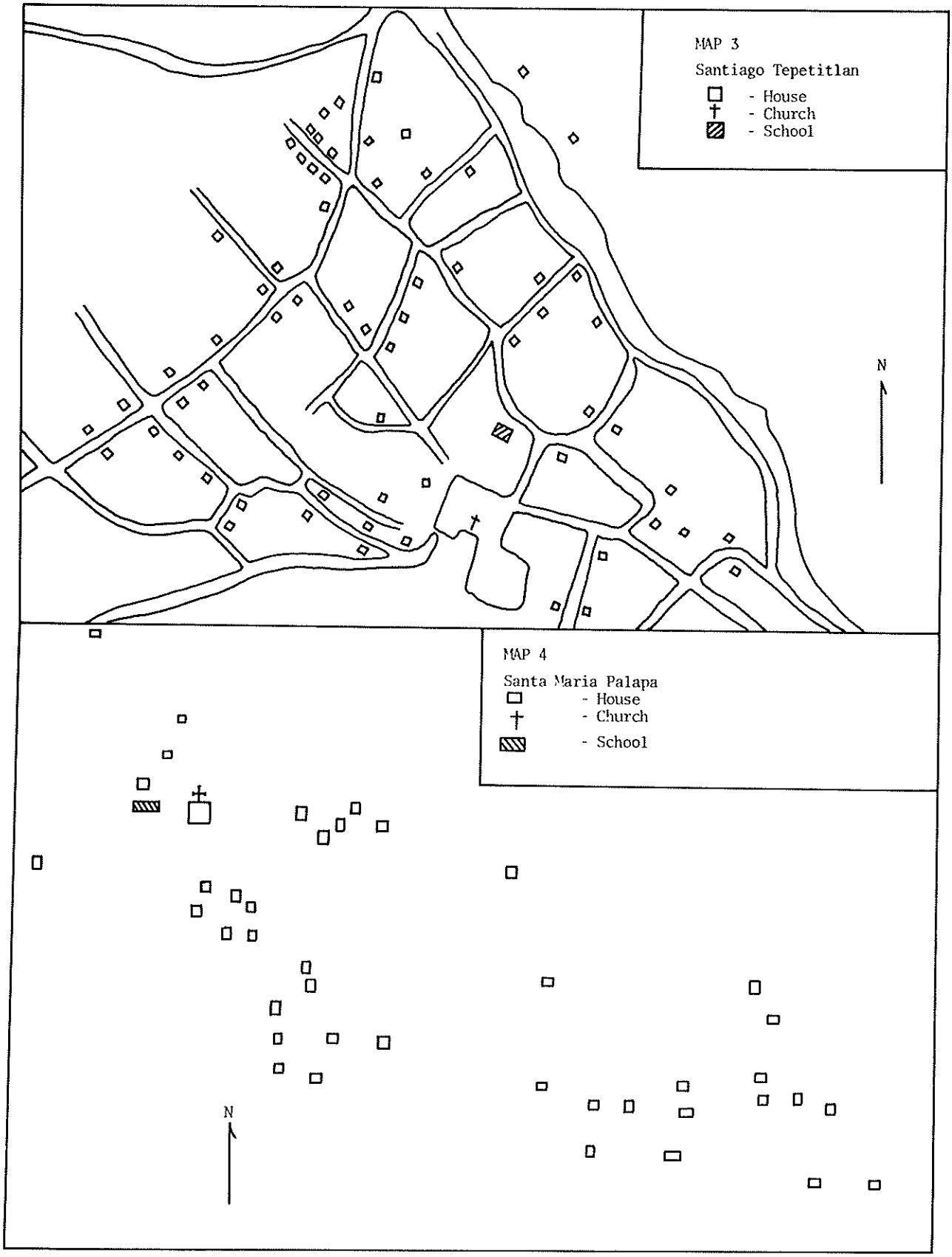


MAP 1
San Juan Teotihuacan showing the four barrios
- Church
- School
- Barrio limit



MAP 2
Cuanalan
- Railroad
- Church
- School
- Area surveyed in house-to-house survey


MAP 3
Santiago Tepetitlan
- House
- Church
- School
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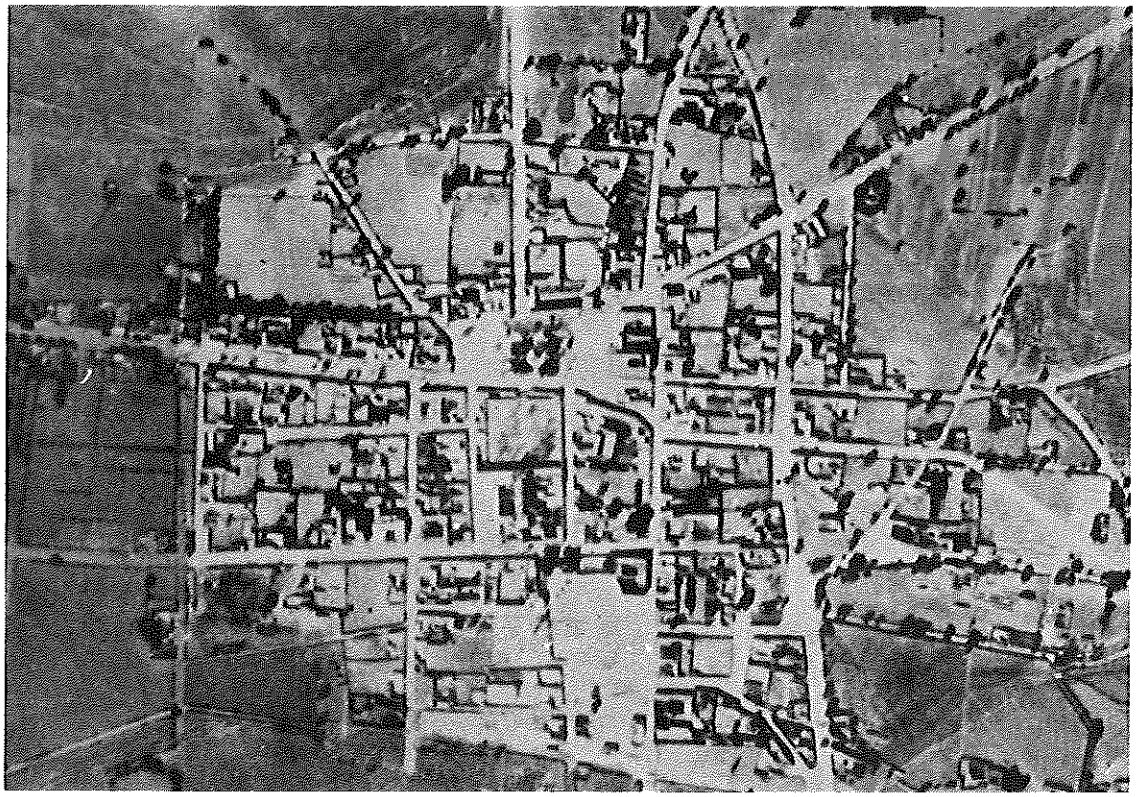
MAP 4
Santa Maria Palapa
- House
- Church
- School
N

Plate 1



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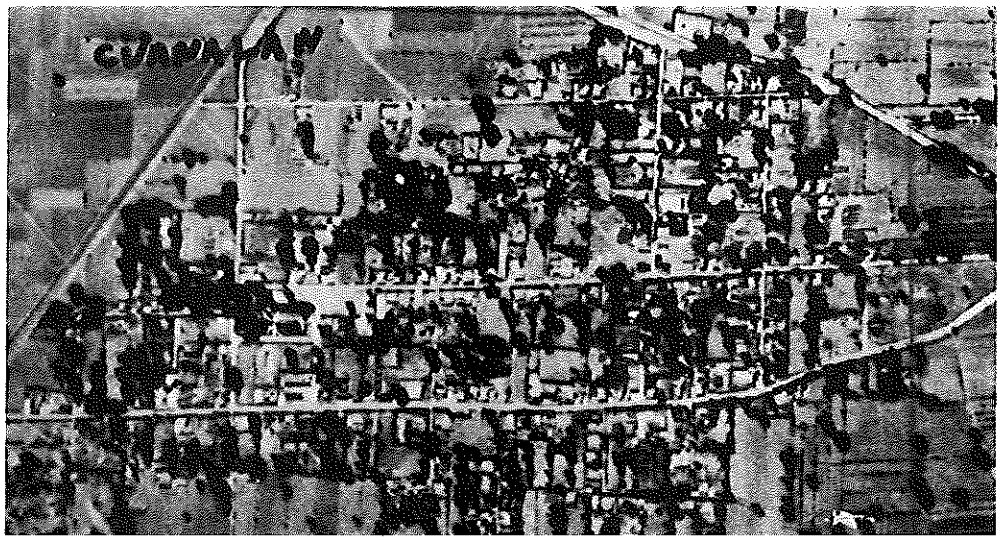

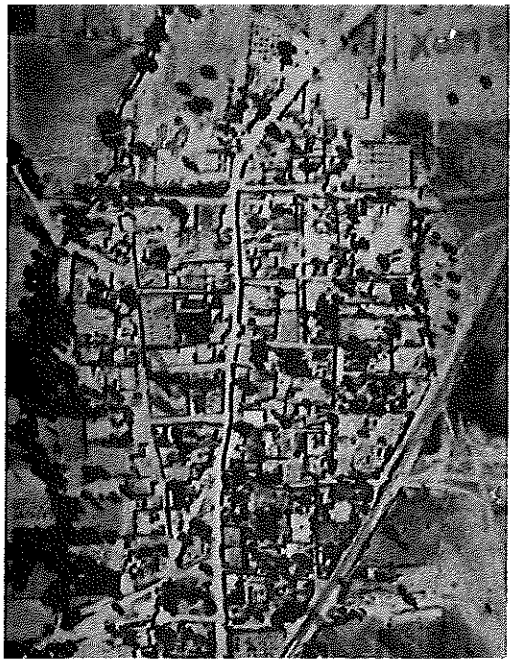

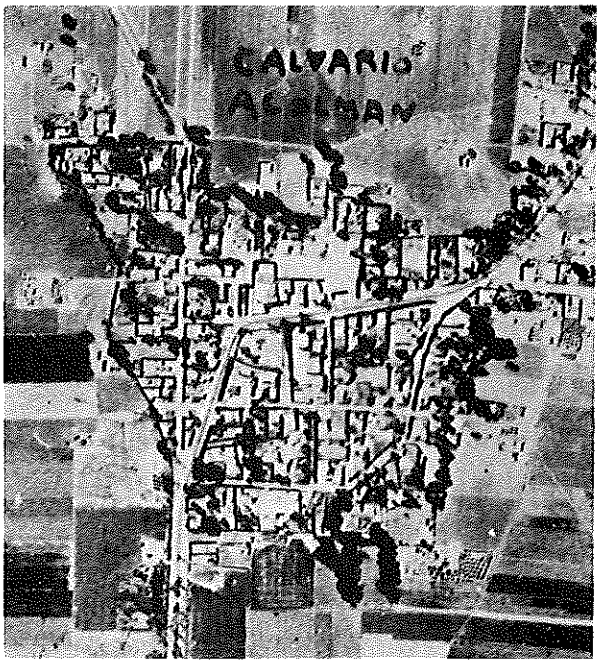

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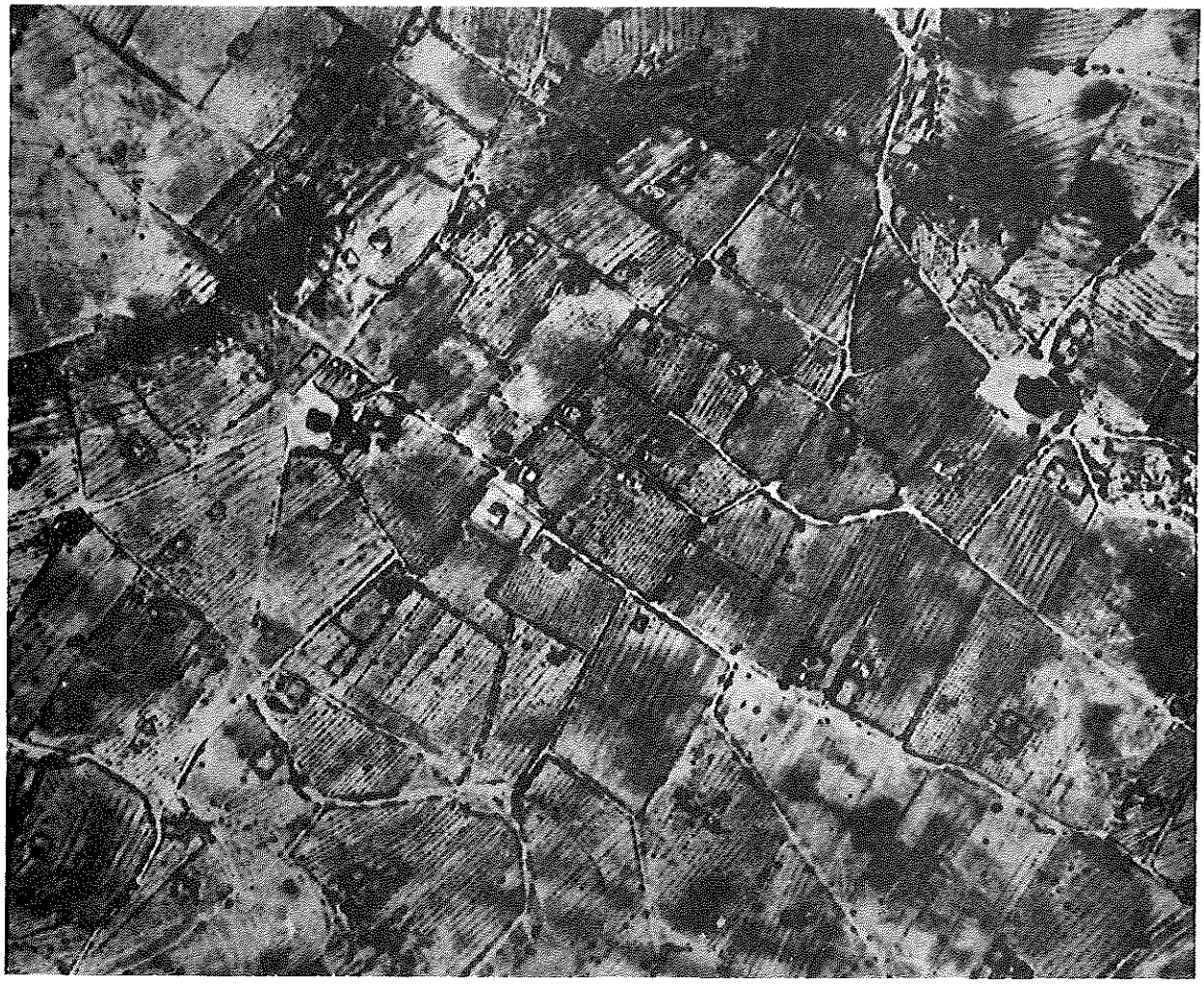
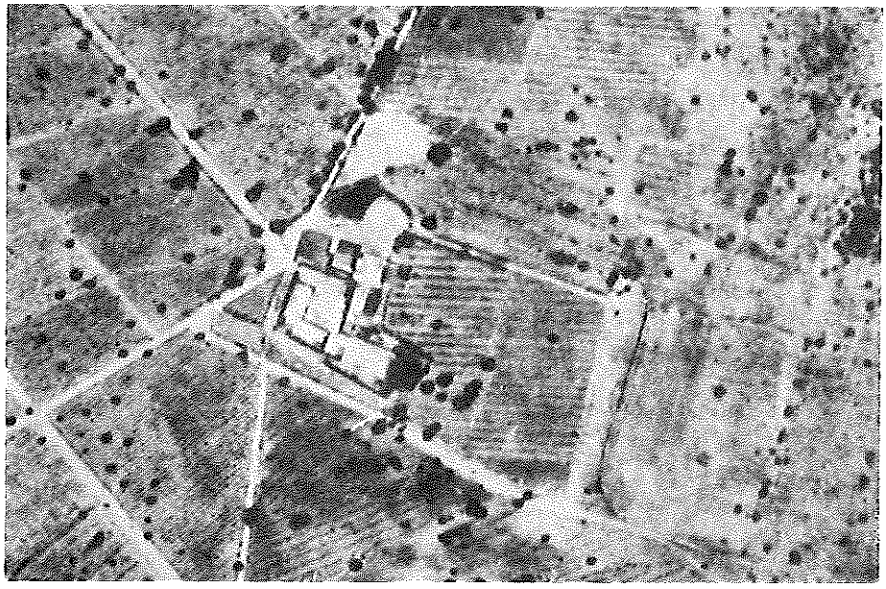
Plate 4





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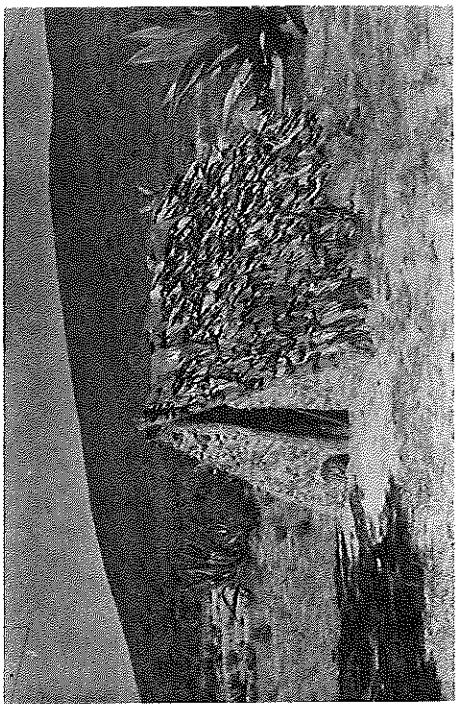

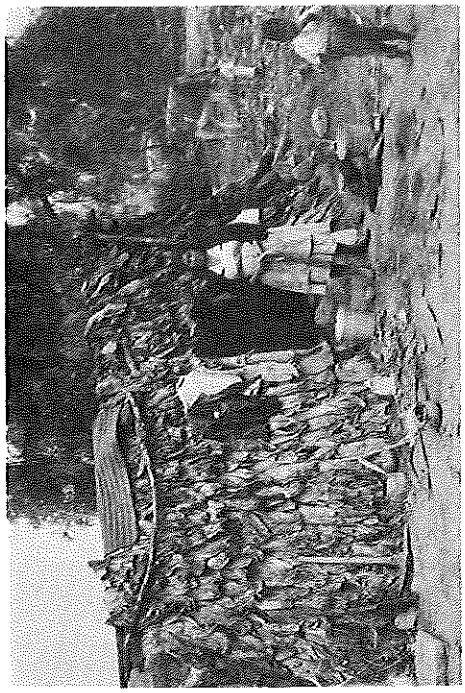

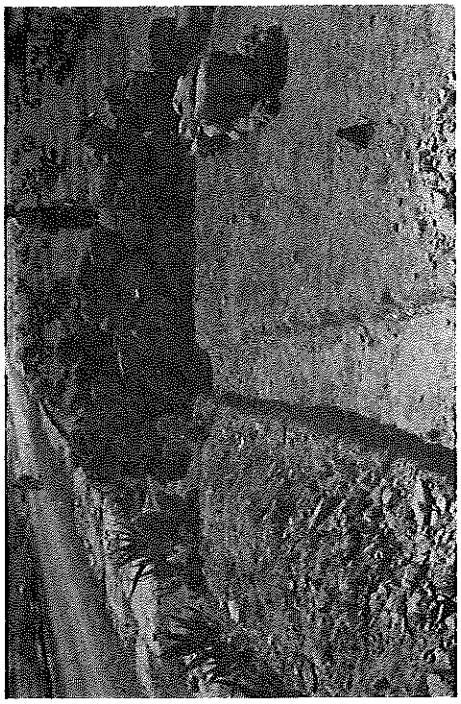

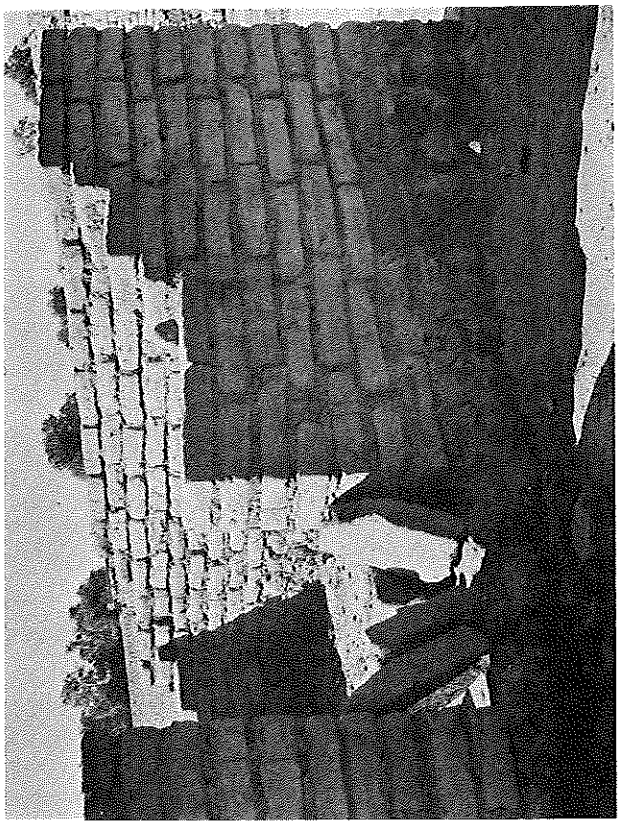

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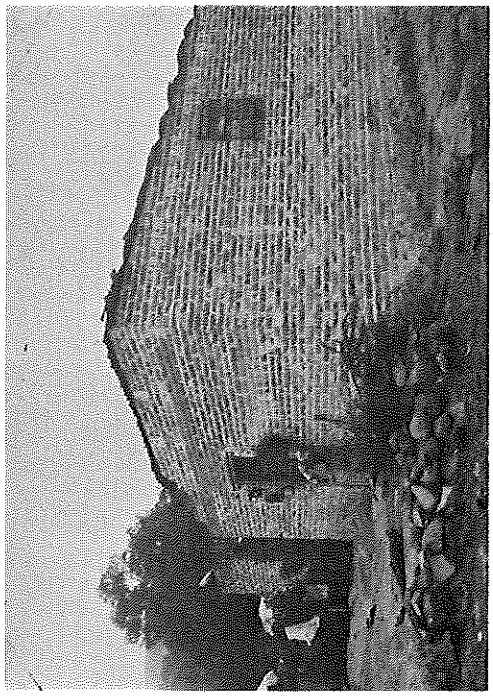

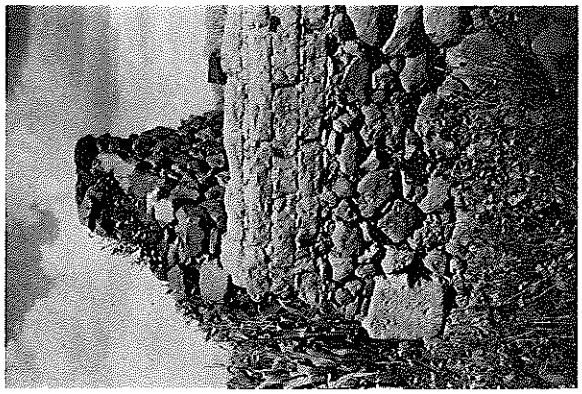

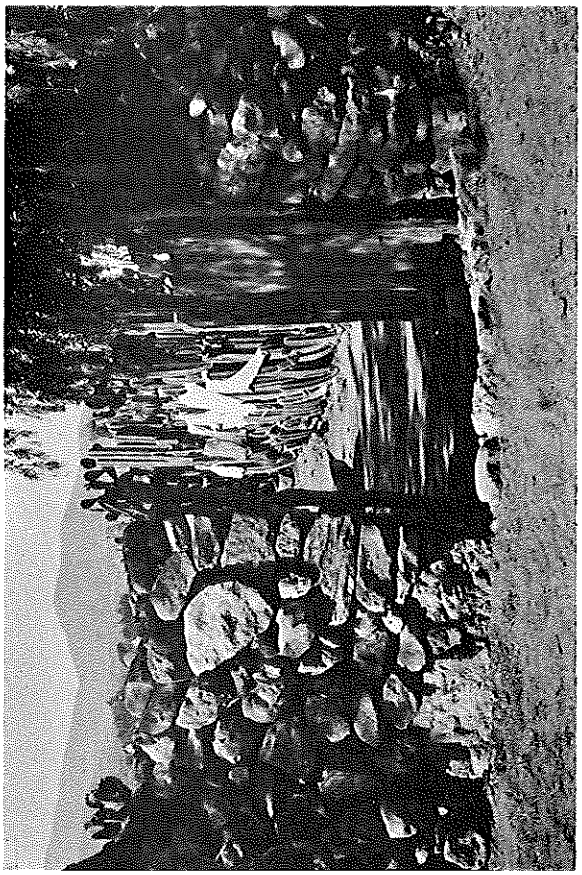

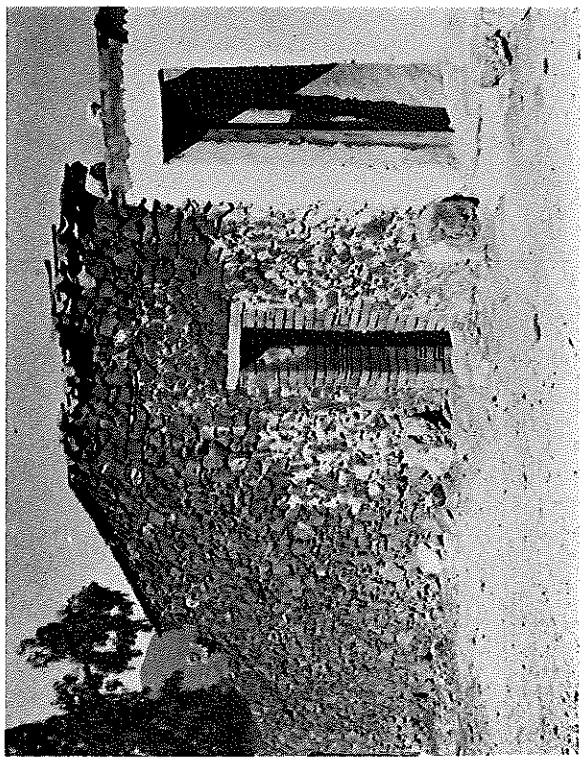

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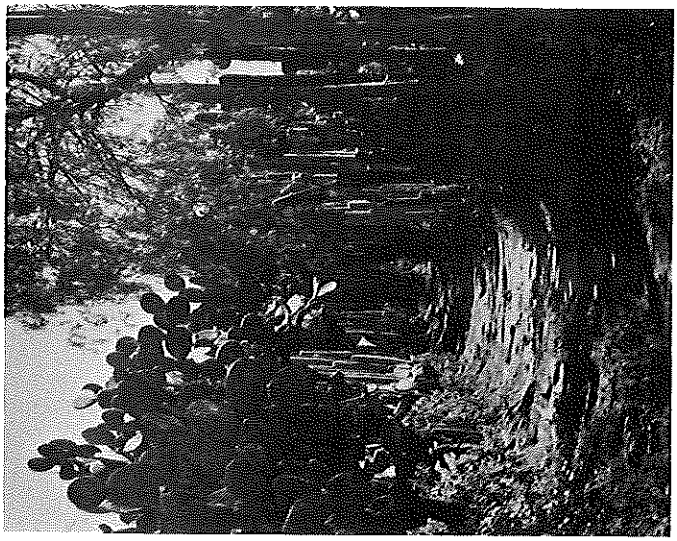

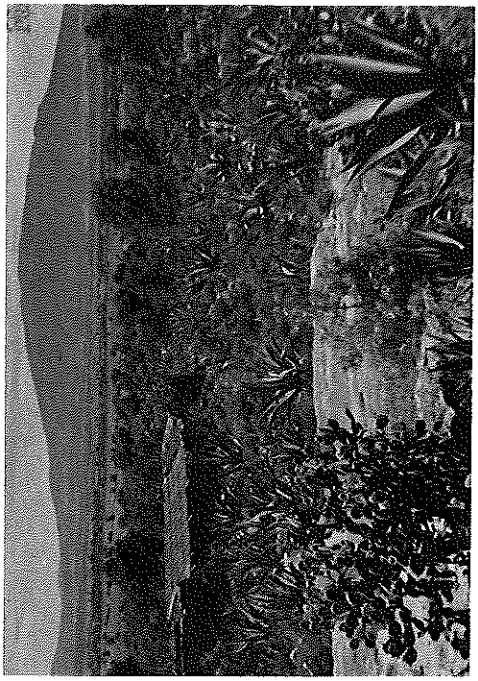

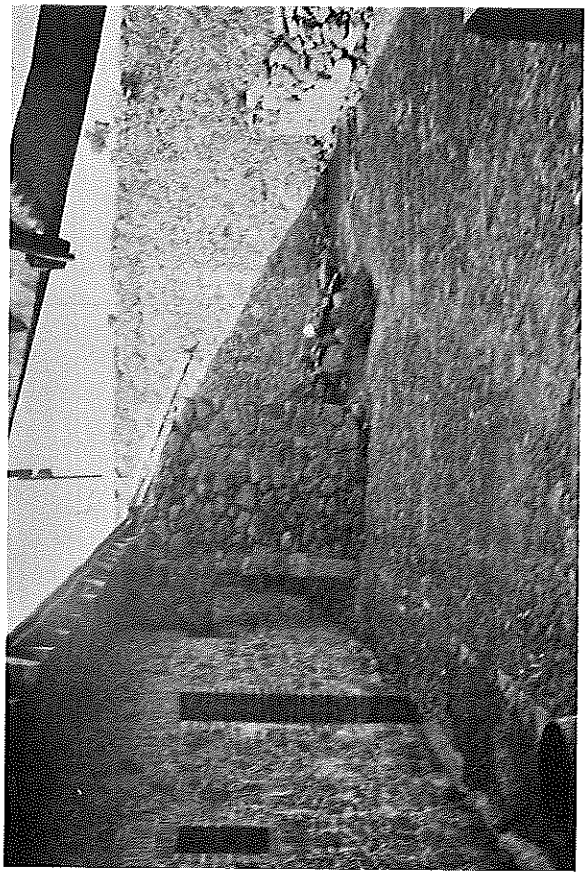

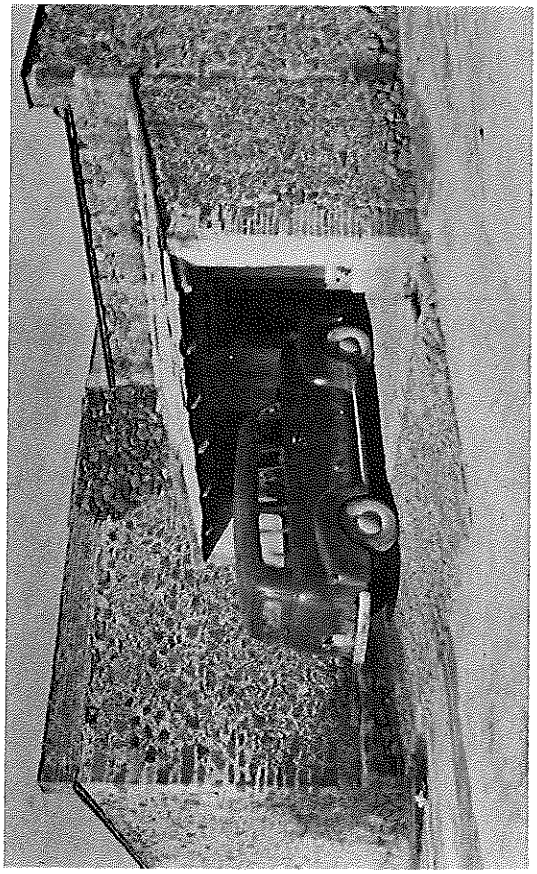

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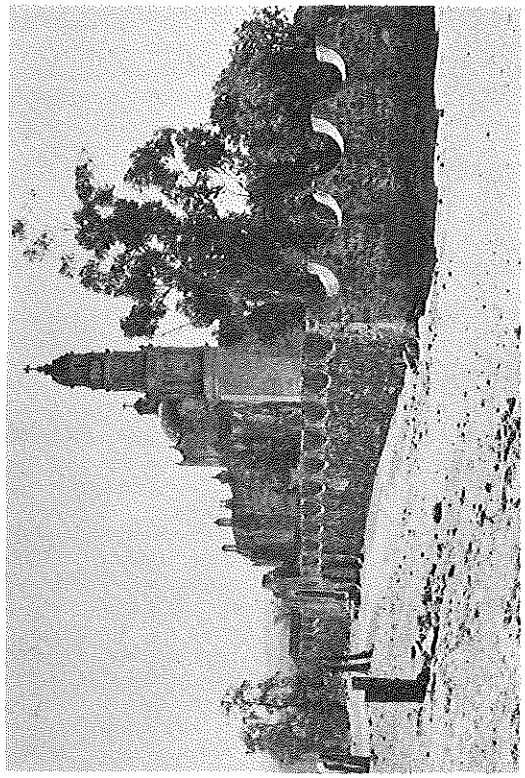

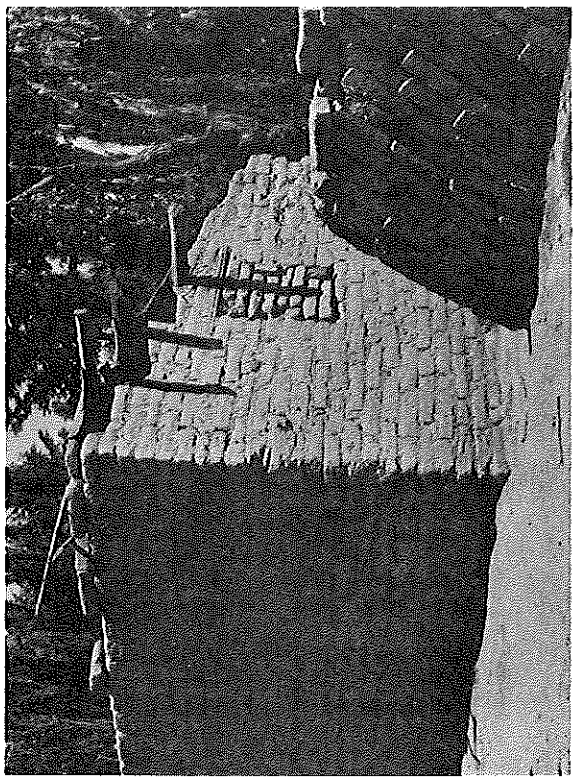

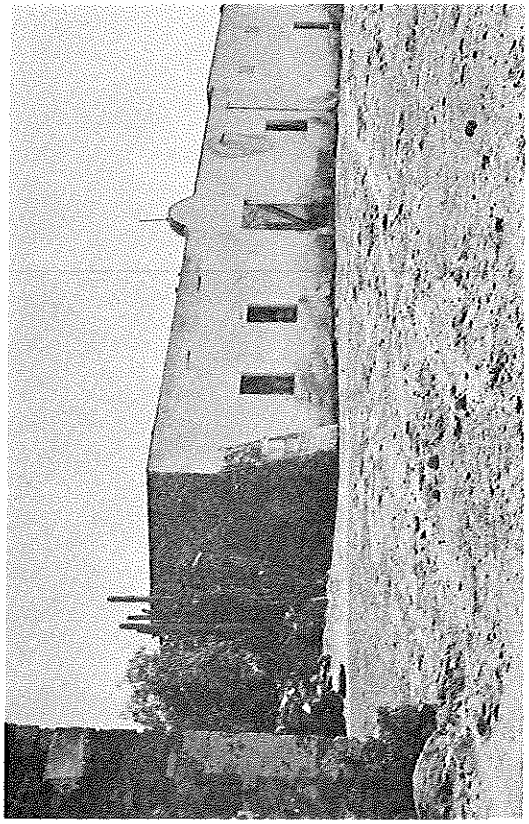

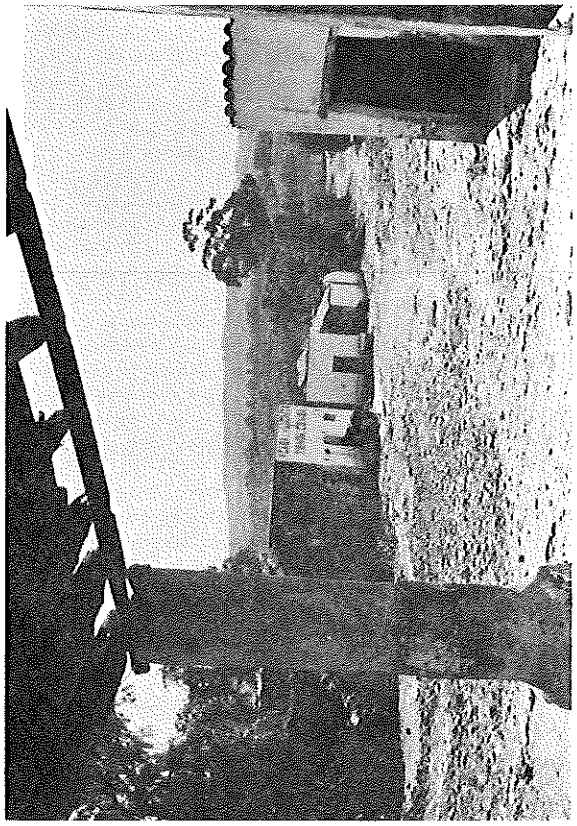

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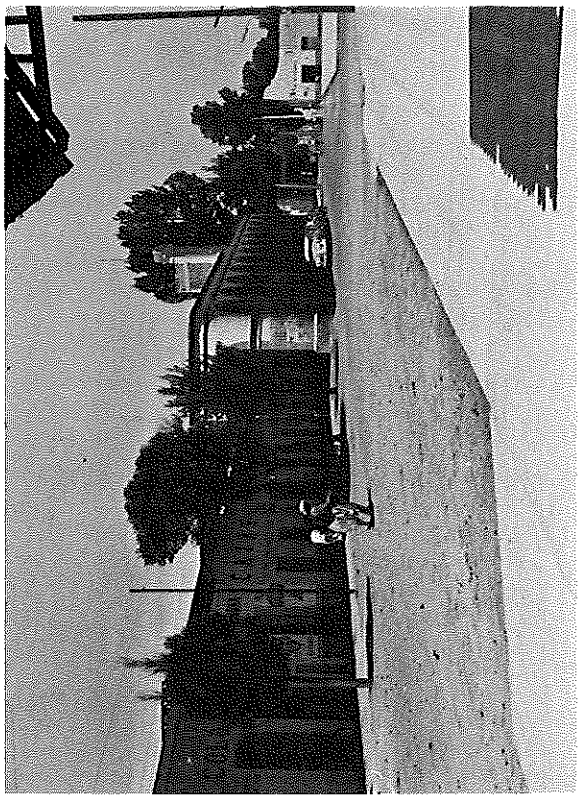

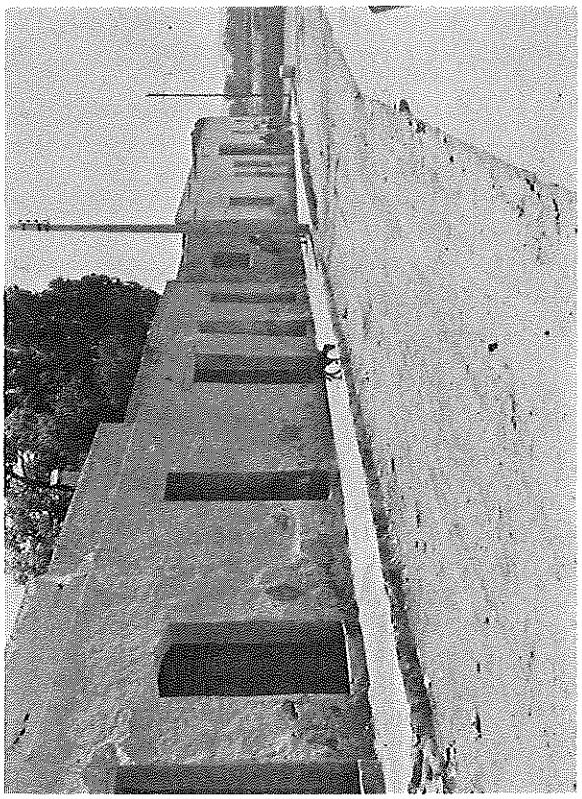

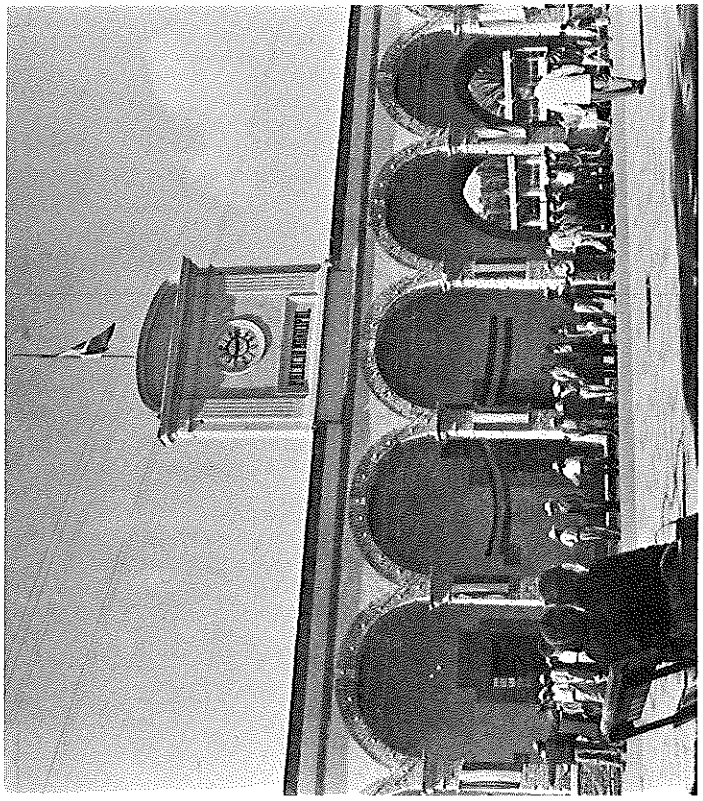

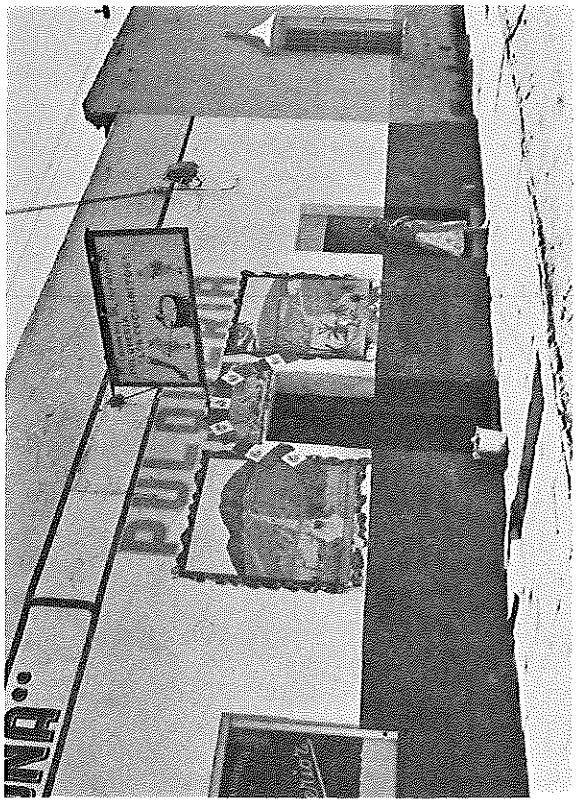

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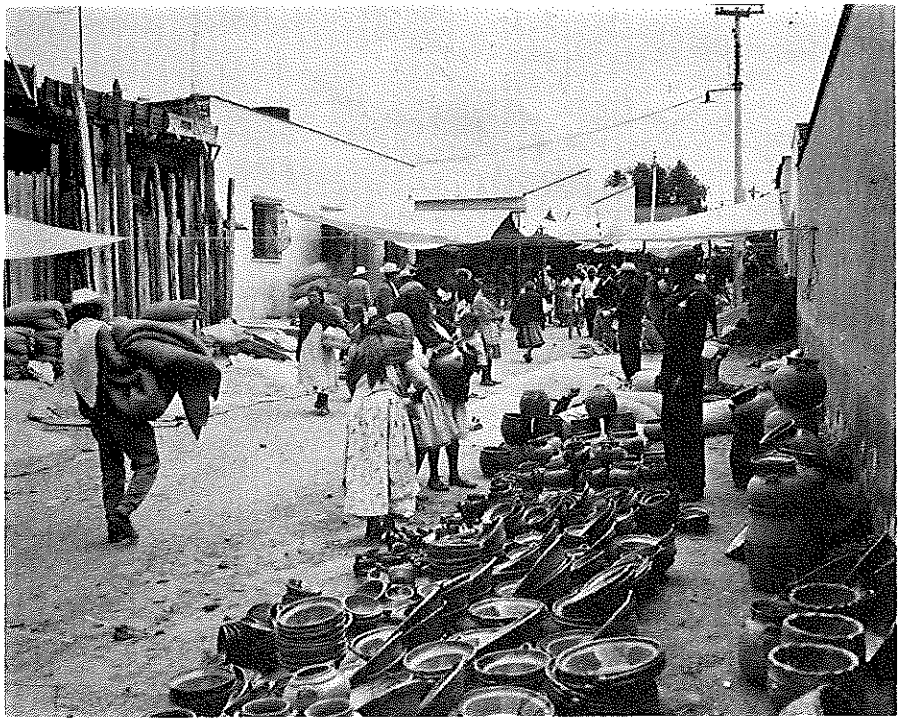

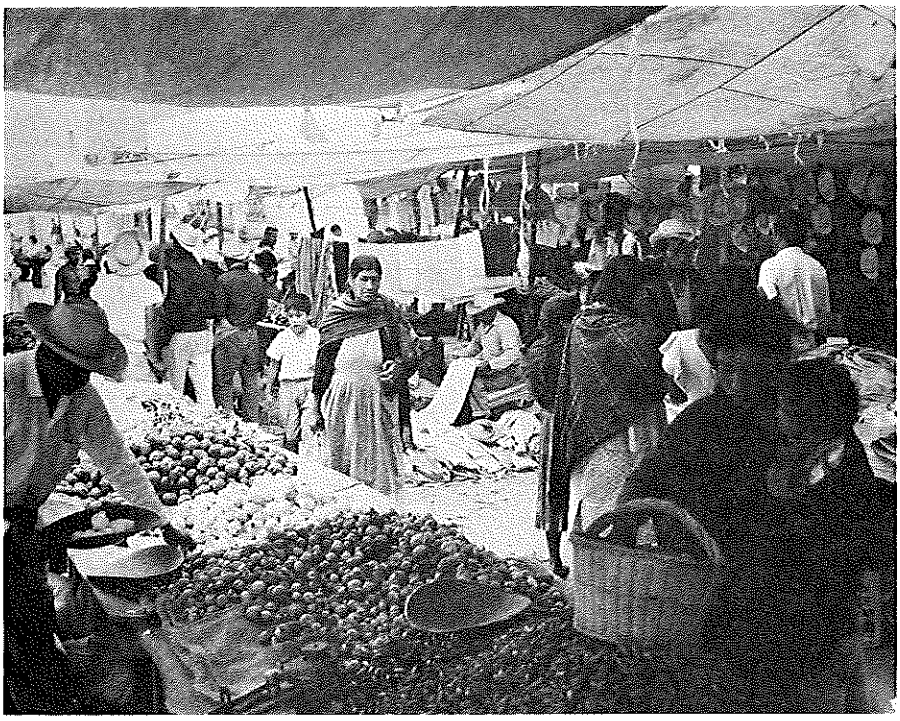

Plate 11

CONTEMPORARY SETTLEMENT PATTERNS:

THE CERRO GORDO-NORTH SLOPE

AND

UPPER VALLEY AREAS

by

Thomas Charlton

TABLE OF CONTENTS

Background and Methodology 183

The Cerro Gordo - North Slope Area 184
The Area. 184
Community Patterns. 184
1. Houselots 184
2. House Construction. 185
3. Village and Colonia 194

Zonal Patterns. 202
1. Geographic Patterns 202
2. Cultural Patterns 202

The Upper Teotihuacan Valley 206
The Area. 206
Community Patterns. 206
1. Houselots 206
2. House Construction. 208
3. The Community 214

Zonal Patterns. 232
1. Geographic Patterns 232
2. Cultural Patterns 234

Comments by William T. Sanders 237

Bibliography 240

ILLUSTRATIONS

Fig. 1 - Open Houselot - Colhuacan. 241
Fig. 2 - Obscured Houselot - Colhuacan. 241
Fig. 3 - Walled Houselot - Colhuacan. 242
Fig. 4 - Open Houselot - Maquixco Alto. 242
Fig. 5 - Obscured Houselot - Maquixco Alto 243
Fig. 6 - Walled Houselot - Maquixco Alto. 243
Fig. 7 - Map of San Cristobal - Colhuacan 244
Fig. 8 - Map of Santa Maria Maquixco Alto 245
Fig. 9 - Map of Cerro Gordo, North Slope Area 246
Fig. 10 - Obscured Houselot - San Pablo Isquitlan. 247
Fig. 11 - Walled Houselot - San Pablo Isquitlan. 247
Fig. 12 - Map of San Pablo Isquitlan 248
Fig. 13 - Valley of Teotihuacan - Modern Settlement. 249
Fig. 14 - Relation of Percentage of Extended Families and Average Number of Occupants per Resident Complex 250
Fig. 15 - Correlation of Number of Nuclear Families and Densities of Villages. 251
Fig. 16 - Correlation of Population Density and Land Tenure. 252

BACKGROUND AND METHODOLOGY

In 1964, the author studied the settlement patterns of three communities in and near the Teotihuacan Valley to gain some understanding of the factors involved in their formation. Two of the communities, Santa Maria Maquixco el Alto and San Cristobal Colhuacan, were selected because they provided a link of the archaeological sequence on the north slope of Cerro Gordo to the present. The third village, San Pablo Isquitlan, was studied because of its somewhat unique characteristics in the Middle Teotihuacan Valley. The data obtained from these studies provided a basis for an interpretation of the archaeological settlement patterns in the intensive survey area on the north slope of Cerro Gordo.

In each community similar methodological procedures were followed. Using 1:25,000 and 1:10,000 aerophotos of the region and 1:4,000 and 1:2,000 sheets of the village, combined with the help of several informants; the ejido and private lands, the lands used for the support of the church and the school were mapped and a land use survey of private property was conducted. In all cases, crops, soil types, topographical features and agricultural techniques were recorded. All houses, house ruins and house lots were located on the photos.

Subsequently, plans of each household were drawn, construction techniques noted, and orientation of houses to streets and lots recorded. At the same time informants were used to obtain data on family composition in each household and the relationship of each household to others. These procedures laid the foundation for a final phase of the study, a house-to-house survey, with questions designed to elicit information on social structure, population size and composition, and the nature of the participation of each residential complex within the economic, religious, and political organization of the community. While walking many kilometers of boundary lines and mapping fields and houses, casual conversations with informants provided specific information about agricultural techniques, economic organization, politics, religion and concepts of ethnogeography current in each village. This information provided a background for the house-to-house survey.

THE CERRO GORDO-NORTH SLOPE AREA

The following descriptions of the contemporary settlement patterns on the north slope of Cerro Gordo and in the Upper Teotihuacan Valley consist of revised and enlarged versions of sections of Chapter IV of my Ph.D. dissertation, Archaeological Settlement Patterns: An Interpretation (Charlton, 1965). During the first six months of 1964, fieldwork in the villages of Santa Maria Maquixco el Alto, San Cristobal Colhuacan, and San Pablo Isquitlan was conducted. These materials, combined with additional data collected by William T. Sanders, Richard Diehl, and the author, form the substance of the following sections.

The Area

The Cerro Gordo-North Slope area lies outside the Teotihuacan Valley hydrographic basin. It includes the northern slopes and drainage basin of Cerro Gordo. Unlike the southern slopes, which are steep and end abruptly in an alluvial plain, the northern slopes are much more gentle. Several low, domed hills, apparently cinder cones, ring the lower northern slopes. Others, with extinct craters, are located to the north and northeast of the slopes. Due to the rugged topography, the drainage from Cerro Gordo to the northern part of the Basin of Mexico has become complex. The pattern begins with a series of deeply cut barrancas in the upper and middle slopes. These drain to the north. Reaching the lower slopes, the cinder cones, and the extinct volcanoes, these streams divert both to the east and to the west. The runoff eventually empties into the floor of the Basin of Mexico after passing through a complex land form pattern of long, low ridges, separated by deep barrancas.

To the south the area terminates with the height of land running from Cerro Tompiate to Cerro Cuajio. The Barranca de los Organos and its tributaries which drain Cerro Tompiate mark the western edge. On the east the upper tributaries of the Barranca de Terrenates drain the northern slopes of Cerros Cuajio and Pelon into the Upper Teotihuacan Valley. Consequently, the eastern border is the height of land on the ridge west of these tributaries. This runs northeast to the hill north of the village of Santo Domingo Aztacameca. It is more difficult to determine the northern boundary of the area with precision. The base of the lower slopes of Cerro Gordo and the termini of the adjacent ridges serve as tentative boundary markers.

Community Patterns

Within this area the settlement pattern of Santa Maria Maquixco el Alto and San Cristobal Colhuacan was studied, the only contemporary communities located there.

1. Houselots (solares)

General - An examination of houselots in both villages reveals that the nucleus of every residential complex consists of two basic structures, the cuarto (living room) and the cocina (kitchen). Although these are usually separate units, a single room at times serves both for food preparation and consumption and as sleeping quarters. When two distinct structures are present the cocina is often built against one wall of the cuarto. Even when physically separate, the two remain close together.

The structures functioning as cuarto and cocina may be either square or rectangular. The plano (shed) roof occurs most frequently, while cuchillo (gable) and boveda (flat) roofs are rare. Windows occur sporadically but chimneys are absent.

Additional structures serving different functions are frequently associated with the cuarto and cocina in a residential complex. Any such complex may include some or all of the following: pig pens, corrals, macheros (stables), turkey and chicken coops, and temascales (aboriginal sweat baths). Further, extra cuartos which function as storage rooms, tinacales (pulque manufacturing structures), tiendas (stores), and molinos (mills), are present in some complexes. The presence of any of the above structures depends upon the economic status of the residential group with respect to the ownership of animals and participation in some non-agricultural economic activities. There is a tendency for older occupied complexes to have a greater variety of structures than those more recently built.

San Cristobal Colhuacan - In this village the structural units included within a residential complex tend to be arranged facing each other across an open, well swept patio. The degree of enclosure varies and in many complexes the presence of low stone walls and cacti huertas (gardens) increase privacy. The ultimate in privacy is attained when high stone walls link the units creating a formal enclosure. In such complexes the doors from the units open directly into a corral-patio which in turn has a single doorway leading either into the huerta or street. Of the seventy-six residential complexes in Colhuacan only seven have such a formal compound.

Santa Maria Maquixco el Alto - In contrast to the open or partially closed complexes which dominate in Colhuacan, the emphasis in Maquixco is on formal enclosures. Thirty-nine residential complexes in Maquixco (of the total one hundred present) are completely enclosed by high walls. In the complexes which lack such enclosing walls the structural units are often tightly arranged, facing each other across a small patio with their blank walls turned to the street. In addition the complex is surrounded by nopals, magueys and trees. Such enclosed and obscured complexes are more common in the central part of the village but also occur in the fringes and the outlying colonias.

2. House Construction

General - The materials used in the construction of units within residential complexes tend to vary with the age and the function of the particular unit, as well as with the village. Since several different construction materials are available it is not surprising to find these combined in a single unit within a complex. Usually, however, one material will dominate even where several are present.

The cuarto, cocina, machero, and temascal tend to be constructed of the most durable available materials. The other associated structures more frequently incorporate perishable materials such as maguey pencas (leaves of the maguey plant), straw thatch and poles.

San Cristobal Colhuacan - On the basis of frequency of occurrence the preferred building materials for cuartos in Colhuacan tend to be stone, adobe, and xalnene (a local term used to describe a volcanically derived conglomerate). There is the occasional use of brick, tepetate ("softly consolidated calcareous deposit" (Cook 1958:7), and wattle and daub to construct cuartos.

The roof is usually constructed of a wooden framework covered with tiles (here always in the form of overlapping half cylinders). This is true of both the plano roof, which is the least expensive of roof types, and the cuchillo roof. The boveda roof uses flat tiles or bricks which are laid in mortar over wooden beams and then covered with a layer of concrete. This is the most expensive type of roof to construct. In Colhuacan the plano roof is dominant with limited occurrence of either boveda or cuchillo style roofs. Thatch, corrugated tarpaper, corrugated tin, and corrugated asbestos occur sporadically as roofing materials.

Statements from inhabitants in Colhuacan indicate that materials preferred for the construction of the cocina are the same as those used in constructing the cuarto. However, observations of cocinas show that there is a difference between the preferred materials and the materials actually used in the construction of most cocinas. The cocina, whether a separate or an attached structure, is frequently built of less substantial materials and with less care in construction than is the cuarto. This is most apparent in the roofing materials which often consist of maguey pencas. Thatch, or loosely piled stones and xalnene, make up the walls.

The other structures associated with residential complexes are also built of less permanent materials including, maguey pencas, brush, and thatch. Upon occasion old cuartos function as macheros and the temascal (of which there is but one in Colhuacan) is built of stone.

The community buildings, the church, the school, and the delegacion (town hall), are constructed of stone. Interior and exterior walls in these buildings are covered with painted plaster. Such treatment of the walls of residences occurs infrequently in Colhuacan.

Most of the materials employed in construction in Colhuacan are available locally, either as primary resources or as by-products of other activities. Stone, usually a type of basalt, occurs both in surface concentrations and in deposits of some depth. Frequently there is a concentration of boulders in the barrancas. Xalnene and tepetate form the subsoil of the entire region and are exposed extensively as a result of erosion. I noted only one stone quarry; actually a massive outcrop of basalt boulders which are easily dislodged and require virtually no extensive quarrying operations. This is located southeast of the town on a hill known locally as La Majada Vieja. No specific sites were observed from which either xalnene or tepetate are regularly obtained. Both are widespread in distribution throughout the area. Cascajo (volcanic cinders) occurs in Cerro Aguatepec and a number of mines have been dug near the top of the hill to obtain this material. It is used with lime in the manufacturing of plaster. Although the stone quarry belongs to the town, the cascajo mines are private property. Consequently one must pay for either permission to dig or for the material obtained from the owner.

The manufacture of adobes in Colhuacan is a specialized task practiced part-time by one individual. The adobes are rectangular and mold-made. The future house owner will arrange to have enough adobes made and then purchase them from the adobe maker. Mortar used in both stone and adobe construction consists of a mixture of mud and straw. Such mortar is prepared during construction. Cerro Gordo provides wood for roof frameworks and pole wall construction. Local soils provide the daub. Magueys which have ceased to produce agua miel (a sap which forms the base for pulque) supply pencas for roofing some structures while thatch, usually consisting of straw obtained from the threshing of barley, is used as well.

Rather poorly fired red bricks and tiles are obtained from San Bartolome Actopan. The cement used for mortar and the lime for plaster are purchased in Santa Clara, a northern suburb of Mexico City. Other items such as iron rods for reinforced concrete construction; and corrugated tin, asbestos, and tarpaper used for roofing; are also purchased in Santa Clara and transported by bus to Colhuacan.

Although there are two men in the village who are recognized as part-time masons, knowledge of techniques needed in building a house of stone, adobe, or pole and thatch seems to be quite general. While in the village I observed three houses under construction. One of the masons was building a stone house for his son and he worked alone. The second house, of adobe, was also being built by a man working alone. He did not consider himself to be a mason and was not recognized as such by other people in the village. In the third case the materials used were brick and reinforced concrete. The unit under construction was an addition to an older complex. Two masons from Santo Domingo Aztacameca were working on this structure. Since this was only the second brick structure in Colhuacan it is possible that they were needed as the result of the inexperience of local persons in building with the new materials. The local explanation was that they worked faster than village masons.

I did not observe the major portion of the construction of the brick house and cannot comment on the procedures involved. The stone house, a single room unit, was being built on eroded tepetate near the edge of the Barranca de San Cristobal. The stones were brought uncut from the quarry by sledge or packed on mules and burros. The mason used two parallel strings tied to stakes at opposite ends of the proposed wall to guide first, the excavation of a trench into the tepetate, and then the construction of the wall. The trench was about twenty centimeters deep. Construction began in the trench using both uncut and roughly faced stones. The mortar was of mud and straw. Some attempt was made to face the exteriors of the wall with shaped stones (restricted to the outer surface). The corners and the edges of the doorway were constructed of well squared stones. A plumb bob was used to keep the walls perpendicular. Stones were cut by hammer and chisel, and a mason's trowel was used to apply mortar.

The adobe house was under construction on an uncultivated terrace. The procedure followed was quite similar to the above. First, a low stone wall about fifty centimeters above the surface of the ground was constructed. This wall, which was also inserted in a trench, served as the base upon which the adobe wall was built. The guide lines, tools, and mortar were identical to

those used in the construction of the stone house described above. The room measured about two and one half meters by three meters, with a single door placed in one of the long walls. There were no windows and the floor was of earth. The roof was of the plano type, covered with corrugated asbestos. Earth floors and windowless rooms are common throughout the village although some stone floors do occur and the new brick house has a concrete floor.

The residential complexes built with the above techniques and materials vary in details but fall into two major categories mentioned earlier. The formal enclosure, of which there are only seven examples in Colhuacan, consists of contiguous units arranged in a rectangle or a square facing a patio and includes a single exit. In those cases where there are too few units to form such a compound a high wall will complete the enclosure. In the informally arranged complexes the units, when there are more than one, tend to be separate and not linked with enclosing walls. Fifty of the fifty-seven occupied residential complexes in San Cristobal are of this type. Only ten of the nineteen unoccupied complexes were adequately preserved to determine their precise nature, and all were informally arranged units.

The informally arranged units fall into two sub-categories, those with surrounding, shielding vegetation and those without it. Thirty complexes lack obscuring vegetation while twenty possess it. The screening partially obscures the residential complex from public view and does not enclose the entire houselot. Xerophytic plants such as the nopal and maguey or trees effect the screening.

I should note here that the enclosed residential complex found in Colhuacan, Maquixco Alto, and San Pablo Isquitlan is best considered a sub-type of the compact houselot described by Diehl (see this volume) and Sanders (1965). The difference between the two lies in the number of rooms present and in the procedure of construction. The compact houselot is distinguished by continuous conjoined rooms placed around the outside of the complex. The formal enclosure which I have mentioned consists of several rooms, frequently separate from each other but joined by a wall. In the compact houselot the construction procedure involves a continuous string of conjoined rooms placed around the edge of the lot to provide full enclosure. In the formal enclosure the procedure has been to link isolated rooms into a compound through the construction of a wall which joins them.

Sanders (1965: 55) has described the compact houselot as follows:

> The houses are predominately of the flat, brick-concrete type with constructed floors. In this case structures are conjoined, sharing walls and a continous roof, and strung along the periphery of the houselot forming a solid outer wall on the street interrupted only by doors, and, more rarely, windows. One or several courtyards of varying size may be in the interior.

The compact houselot is almost absent from villages but occurs frequently in the urbanized communities, such as San Juan Teotihuacan and Otumba. The enclosure aspect of each is undoubtedly related to the same factor, high internal population density within a community and economic status of the householder. The differences in room organization within the enclosure are probably related

to the differences in social structure between urban and rural communities. The occupants of an enclosed residential complex in a rural community are almost always related to each other, often as members of an extended family. In the urban community the occupants of a compact houselot are frequently unrelated. Exceptions are cases of well-to-do nuclear families who occupy the entire houselot.

> With the exception of the few cases where several small apartments are grouped around a small courtyard and therefore share a street entrance, each living unit has its own ingress directly from the street; the blocks do not have communal main entrances, nor does the population of a single property share a common central courtyard. There are no common ritualistic structures and in no way do the occupants make up any kind of organized social group. (Sanders, 1965: 56).

Each of the nuclear families within a compact houselot has its own kitchen. Within the formal enclosures there is only one hearth for the entire social unit.

Figures 1-3 illustrate examples of the varieties of residential complexes. Figure 1 represents a complex in which two brothers live with their wives and children. A couple with their children live in the complex depicted in Figure 2. An elderly widow and her unmarried son, age 36, reside in the complex illustrated in Figure 3.

Santa Maria Maquixco el Alto - In Maquixco as in Colhuacan the units within any single residential complex are frequently constructed of different materials. Upon occasion a single unit will incorporate several different materials. The presence of different materials within a single complex reflects the age and the function of the particular unit and the economic status of the owner at the time of the construction of the unit.

The preferred materials for the construction of cuartos and cocinas, both in terms of occurrence and verbal statements, are stone and adobe. Xalnene, brick, wattle, and maguey penca cocinas and cuartos do occur but rarely.

The roofs used are identical to those in Colhuacan The plano style roof is the most common form with infrequent occurrence of either boveda or cuchillo style roofs. The half cylindrical tile is the usual roofing material for cuartos and cocinas with plano and cuchillo style roofs. Other materials used include, corrugated tarpaper, corrugated tin, corrugated asbestos, maguey pencas, thatch, and a mixture of earth and ashes. Thatched roofs in Maquixco and Colhuacan are generally associated with cuchillo style roofs. The boveda roof of timber, mortar, and bricks or tiles occurs but is not common.

In contrast to Colhuacan there is a tendency for the construction of more substantial macheros. These, with tinacales, tiendas, and garages are frequently as well built as cuartos, and in some complexes former cuartos are used. The temascales, associated with nineteen complexes, are all constructed of stone. The majority are not in use.

More perishable materials are used for the construction of corrals, pens and coops; and include maguey pencas, brush, poles, and thatch. These are

very similar to those found in Colhuacan.

The church, school and delegacion building are all of stone, with plastered and painted walls in some parts of each. Such plastering and painting occurs infrequently in residential complexes in Maquixco.

The materials used in construction in Maquixco come from the same sources as those in Colhuacan with the following exceptions. Stone is obtained from a very rocky hill known as Cerro Tezqueme, which belongs to the church of the village. Cascajo is purchased from a family which owns half of Cerro Aguatepec and possesses a mine there, quite close to that of Colhuacan. One person in the village makes adobes as a part-time specialist. There is a kiln in the village which was once used to make tiles and bricks but is no longer in service.

In Maquixco there are two men recognized as masons and who work at this in a part-time capacity. Both were working while I was in the village, at a daily wage of twenty pesos. One was building an adobe house. The owner acted as his assistant. The other was repairing an old stone wall and extending it to form a sheep enclosure for the owner of the complex. In this case too the owner acted as an assistant while the mason directed the work, shaped the stone and laid the courses of masonry. No brick houses were observed under construction while in Maquixco but between my departure in 1964 and my return in 1966 my informant had added a brick cuarto to his complex. The construction was undertaken by a compadre of his who lives in Mexico City. Again, it is possible that the handling of bricks and reinforced concrete requires special skills which have not as yet diffused to these villages. From my observations of the stone and adobe construction it is safe to say that the techniques and tools are the same as those described for Colhuacan.

The residential complexes in Maquixco fall into the same categories described for Colhuacan. The frequency of occurrence of the types vary as Table 1 illustrates.

Table 1

TYPES OF RESIDENTIAL COMPLEXES

VILLAGE	WALLED	OBSCURED	OPEN	UNKNOWN
S. Cr. Colhuacan	7 - 0*	20 - 2*	30 - 8*	4*
(out of village area)				5*
Sta. M. Maquixco				
Core	29 - 5*	27 - 4*	12 - 3*	2*
Periphery	2 - 1*	4 - 2*	0 - 1*	
Colonias: Teclalo	1 - 0*	0 - 0*	2 - 0*	
San Jose	0 - 0*	1 - 0*	0 - 0*	
Aguatepec	0 - 1*	0 - 0*	1 - 0*	
(out of village area)				4*

Note: * denotes unoccupied.

Table 2

WALL CONSTRUCTION MATERIALS - CERRO GORDO - NORTH SLOPE

MATERIALS	Colhuacan No.	%	Maq. Core No.	%	Maq. Periph. No.	%	Aguatepec No.	%	S. Jose No.	%	Teclalo No.	%	Out of Village No.	%
Stone	16-4*	26.31	30-8*	46.34	0-3*	30.0					2-0	66.6	0-1*	50.0
Stone and Adobe	12-0*	15.78	28-2*	36.58	1-1*	20.0			1-0	100.				
Stone, Adobe and Xalnene	5-3*	10.52												
Stone, Adobe and Brick			1-0	1.21	1-0	10.0								
Stone and Xalnene	11-8*	25.00												
Stone, Xalnene and Brick	2-0	2.63												
Stone, Adobe and Tepetate													0-1*	50.0
Stone and Brick														
Stone and Pencas	1-0	1.31												
Stone and Thatch	1-0	1.31												
Stone and Tepetate	1-0*	2.63												
Adobe	4-2*	7.89	8-3*	13.41	3-0	30.0								
Adobe and Thatch	2-0	2.63												
Adobe, Thatch and Xalnene					1-0	10.0								
Brick			1-1*	2.43										
Xalnene	1-1*	2.63					1-1*	100.0						
Tepetate											1-0	33.3		
Wattle and Daub	1-0	1.31												

Note: * indicates unoccupied residential complex.

Table 3

ROOF TYPES AND MATERIALS-CERRO GORDO - NORTH SLOPE

	Colhuacan		Maq. Core		Maq. Periph.		Aguatepec		S. Jose		Teclalo		Out of Village	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Roof Types														
Plano	41-7*	63.15	55-9*	78.04	3-1*	40.0					2-0	66.6		
Plano-Cuchillo	3-0	3.94	6-0	7.31	3-1*	40.0	1-1*	100.0	1-0	100.	1-0	33.3		
Cuchillo	4-2*	7.89	3-1*	4.87	0-1*	10.0								
Boveda			1-0	1.21										
Plano Boveda	8-0	10.52	3-2*	6.09										
Boveda Cuchillo	1-0	1.31												
Plano, Cuchillo, Boveda			0-1*	1.21										
Unknown	0-10*	13.15											0-2*	100.0
Roof Materials														
Round Tile	28-3*	40.78	35-7*	51.21	1-1*	20.0					1-0	33.3		
Round Tile & -asbestos	3-0	3.94	3-0	3.65										
-thatch	5-1*	7.89	2-0	2.43	2-0	20.0	1-0	50.0						
-tin	1-0	1.31	1-0	1.21										
-tin and tarpaper			2-0	2.43							1-0	33.3		
-asbestos and tarpaper	1-0	1.31												
-tarpaper	1-0	1.31	8-0	9.75										
-asbestos and thatch	1-0	1.31												
-asbestos, thatch and tin	1-0	1.31												
-pencas			4-0	4.87			0-1	50.0			1-0	33.3		
Flat Tiles			1-0	1.21										

Table 3 continued

	Colhuacan		Maq. Core		Maq. Periph.		Aguatepec		S. Jose		Teclala		Out of Village	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Flat Tiles &														
-asbestos			0-1*	1.21										
-round tiles	8-0	10.52	3-2*	6.09	0-1*	10.0								
-pencas	1-0	1.31												
Tin			0-1*	1.21										
Asbestos	0-2*	2.63												
Tarpaper			4-0	4.87	1-0	10.0								
Tarpaper and														
-asbestos	1-0	1.31												
-pencas			1-0	1.21	1-0	10.0								
Thatch	5-1*	7.89	1-0	1.21	1-1*	20.0			1-0	100.0				
Thatch and														
-pencas	0-1*	1.31	2-0	2.43										
-tin	1-0	1.31												
Pencas			1-0	1.21	0-1*	10.0								
Unknown	0-11*	14.47	0-3*	3.65									0-2*	100.0

Note - * indicates unoccupied residential complex.

Walled formal enclosures are much more common at Maquixco as are informally arranged complexes. Open informal complexes are much more common in Colhuacan. As shall be shown later these figures are related to population densities within the villages. Figures 4-6 illustrate examples of each variety of complex found in Maquixco. The complex represented by Figure 4 is occupied by an unmarried elderly woman. The occupants of the complex depicted in Figure 6 include a man and his wife; their married daughter, her husband and their children. Figure 5 illustrates a complex occupied by a man, his wife, and his unmarried children.

3. Village and Colonia

General - Although the two villages have similar residential complexes in terms of type and construction they differ in the arrangement of these complexes within the available environment. The plaza-church-delegacion-school complex forms a distinct unit within each village. The villages vary in the arrangement of residential complexes with reference to each other and with reference to the complex of public buildings as a single unit.

The surface occupied by each village (see Figures 7-8) was determined by including all houselots (solares), adjacent cultivated lots (huertas), and peripheral lands considered as huertas (huertas de campo) by the inhabitants. By following this procedure a single residential area was established for San Cristobal Colhuacan. In the case of Colhuacan the physical community corresponds exactly to the social community. Maquixco, however, does not have a single continuous area where the entire social community of Maquixco resides.

The huerta boundary delimits a large area within which most of the population lives. Some families live outside this area in their fields or campos. In order to present a clear picture of the Maquixco community pattern three areas of occupation have been defined. These are: the core, an area determined by the grid plan and the residential complexes located within it; the core and the periphery, an area determined in the same manner as the Colhuacan village area; and the colonias, Aguatepec, San Jose, and Teclalo, each composed of residential complexes separated by true fields (campos) from the core and periphery area. The occupants of Maquixco recognize these three areas. In making comparisons I shall use primarily the Maquixco core area, where most of the population resides (see Tables 4 and 5).

With the exception of the colonias of Maquixco the lowest per hectare density of occupied residential complexes occurs in Colhuacan. In the core area of Maquixco the density is slightly more than twice as great as that in Colhuacan. Population densities in the two villages follow similar proportions (see Table 5). The average number of persons per occupied residential complex remains roughly the same for each.

Table 4

VILLAGE AREAS AND RESIDENTIAL UNITS

VILLAGE	AREA	UNITS		DENSITY
S. Cr. Colhuacan	27.75	57	14* 5*#	2.05
Sta. M. Maquixco				
Core	16.00	68	14* 2*#	4.25
Core and Periphery	34.40	74	18*	2.15
Colonias: Teclalo	3.00	3		1.00
San Jose	.50	1		2.00
Aguatepec	.50	1	1*	2.00

Note: All areas are in hectares.

* denotes unoccupied
\# denotes located outside village area. Densities are for occupied complexes per hectare.

Table 5

POPULATION DENSITY

VILLAGE	POPULATION	PER COMPLEX	PER KM^2
S. Cr. Colhuacan	320	5.61	1153
Sta. M. Maquixco			
Core	327	4.80	2044
Core and Periphery	360	4.86	1046
Colonias	27	5.40	675

The increased population density in the core area of Maquixco results from the concentration of residential complexes similar in size to those of Colhuacan into a much smaller residential area. The number of persons per unit remains similar.

The high percentage of unoccupied residential complexes in Colhuacan and Maquixco, twenty-five percent and twenty-one percent respectively, reflects the population losses of the two villages since 1940 (see Table 6).

Table 6

SURVEY AREA POPULATION 1900-1964

UNIT	1900	1921	1930	1940	1950	1960	1964
San Cayetano	66	22	1	-	-	-	-
Maquixco	369	384	422	439	375	408	387
Colhuacan	182	242	286	326	288	306	320
Total	617	648	709	765	663	714	707
Salinas	389	227	167	13	5	5	
Total	1006	875	876	778	668	722	

The differences in internal arrangements of residential complexes within the two villages described above, in terms of population and residential unit density, can be readily perceived through a casual examination of the physical appearance of each village.

San Cristobal Colhuacan - Within the village of San Cristobal there is only one case in which two residential complexes come into physical contact. All other complexes are completely separate with no clustering present. Although San Cristobal has a few named streets it has no grid plan. Some complexes, the majority now unoccupied, cluster near the plaza on the west side of the Barranca de San Cristobal. On the east side the terrace systems serve as the principle for the plan of the residential complexes.

The complexes are usually constructed on tepetate outcrops above the actual terrace, often at one edge but occasionally in the centre. The building of the house has often preceded the construction of the terrace with which it is associated. As long as a terrace remains productive no structures are placed on it. When productivity decreases, through a loss of water or fresh silt, a house will be built on it. Even in such cases the building is kept at one end of the terrace.

Another significant location for residential complexes is the non-productive land along the edge of the barrance. Some complexes located here are on the edge of the street but others are situated well back into the huerta.

With the exception of areas of bare tepetate most of the residential area of Colhuacan is under some type of cultivation. The older terraces and the barranca edges are covered with pasture, magueys, nopals and barley. Four month and six month maize are planted in the better lands. The best lands within the residential area are located on the northern and southern fringes.

Santa Maria Maquixco el Alto - In Maquixco as in Colhuacan the majority of the residential complexes of all three areas, colonias, periphery, and core, are

separate entities and do not come into contact with their neighbors. In the core, however, with the greater concentration of units, there are a number of contiguous complexes. There are nine cases in which two complexes touch and one case of four complexes so adjoining as to appear from the street as a single structure.

The grid plan of streets which defines the core area serves as the major organizational principle for the location of the residential complexes. These are usually set on huerta edges next to the street, although a few are centrally located. In the peripheral area and in the colonias units are oriented with reference to terraces, huerta edges, barranca edges, and roads. Within the core area the residential complexes are relatively evenly spaced throughout. There is a clustering in the blocks next to the Colhuacan road and the Avenida Jalapa which connects the village to the state highway. The plaza and the jaguey are secondary foci of occupation.

Within the village all lots are under cultivation, usually with maguey and nopal, although some four month maize is occasionally found. In the periphery and the colonias maguey and nopal are often found near the complex with the surrounding fields being planted with barley or maize. The emphasis on cash crops as opposed to staple crops within the core area is apparently a recent development. It stems from two factors, the decreased productivity of the soil caused by erosion and the improved transportation facilities which enable trucks to enter the village and carry pulque and tunas to the markets in Mexico City.

Summary of Community Pattern, Similarities and Differences - The community patterns of the two villages share residential complex types and public building complexes. The arrangements of the residential complexes differ in two features; the formal organizational principle and in density of both occupied units and population. The average number of occupants in each residential unit is similar.

Differences between the villages which I have expressed in ratios of open to closed residential complexes, and contiguous to separate residential complexes, are the immediate results of differences in density of occupied complexes within each town. Privacy is valued. It may be obtained either through distance between residential complexes or by screening the complex from the public with vegetation or walls. The increase in number of walled or screened complexes is directly related to the increase in density of occupied residential complexes.

Differences in type and distribution of crops within the area of the village are also related to population and residential unit densities. Increased density of both will reduce soil fertility and result in the differences noted.

It still remains necessary, however, to account for the differences in population density and characters of house complexes, as well as the absence of the grid plan in Colhuacan. Since this is a significant theoretical problem I shall treat it later using data both from this area and from the Upper Teotihuacan Valley area.

Agricultural Technology and Population - The two villages share a basic agricultural technology with an emphasis on soil and water conservation. This has been

described in detail by Sanders (1965) and is treated by this author in another paper in this volume (Contemporary Agriculture of the Teotihuacan Valley). The environment they exploit is similar. Both communities and their lands are located between 2400 and 3050 meters above sea level and their lands are extremely variable in degree of erosion, soil types and topographic gradients. The exploited area (See Figure 9) is situated on the upper reaches of several barranca systems which drain into Lake Xaltocan from the bases of Cerro Gordo and Cerro Buenavista. Rainfall and hill slope runoff provide the only sources of water. The agricultural technology is applied to capture eroding soil in terraces on hill slopes and in presas (dams) in barrancas. In addition some effort is directed to the diversion of hill slope drainage to the terraces. The great depth of the barrancas prevents effective diversion of their water to irrigate fields other than the presas. Erosion is an omnipresent danger and many sections are severaly eroded. Soil conservation and land reclamation are proceeding in patches, with individuals constructing terraces and presas within their own private property holdings, or within their ejido lands. Both types of holdings are often widely scattered through the area. Hill slopes too steep to cultivate are used for the grazing of sheep and goats. In general the private properties held by the villages since the Conquest are very well preserved. This preservation is particularly good near the villages. The ejido lands formerly owned by the Hacienda Salinas are in a much poorer state of preservation.

San Cristobal Colhuacan and Santa Maria Maquixco el Alto exploit a single microenvironment within the Basin of Mexico. The two villages are located in hill slopes, at or near the headwaters of several barranca systems. Soils vary in depth through the area. Most are shallow and depend solely on rainfall as a source of moisture. A few are deep and so situated as to obtain adequate direct runoff from the slopes resulting in their classification as humedad (with permanent moisture) as opposed to temporal (dependent on rainfall). In summary the agricultural system includes a variety of techniques to prevent erosion and utilize runoff drainage.

The productivity of the lands exploited by Maquixco and Colhuacan is definitely less than that of the lands on the Teotihuacan Valley floor. They produce from one-third to one-half as much again as the Maquixco-Colhuacan lands. It should be noted that the presas and better terraces equal the crop production of lands with permanent irrigation in the Teotihuacan Valley. The lower overall productivity is reflected in the density of persons per square kilometer of exploited lands (See Table 19).

It is quite probable that the lands of Colhuacan and Maquixco could support a much larger population if known local techniques of soil conservation were more generally applied.

Political Organization - Political organization today is imposed on all communities by the State and Federal Governments. Participation in government takes place through the municipio (municipal) system. Maquixco and Colhuacan are in the Municipio of San Francisco Temascalapa. Both are "pueblos" and each elects individuals to fill positions and carry out duties prescribed by the higher levels of government. These positions are identical in the two communities. Except for this participation in the official political structure I observed little political consciousness and no other political organization within the villages. Both villages have occasionally sent regidores (aldermen) to serve

in the municipal government but neither has sent a municipal president. Participation in political office is usually with some reluctance.

Religious Organization - Christianity was introduced to both villages in the decades immediately following the Conquest. Vestiges of Aztec religious beliefs and customs have survived and have been incorporated into the folk-religious beliefs associated with the Roman Catholic Church. Formal church organization and folk beliefs are similar in both villages.

Neither village has a resident priest although both churches date from the Colonial Period. The church of Maquixco has a date of 1598 carved in a stone above the door. Mass is held about once a month when the priest comes from Temascalapa.

Some individuals belong to religious associations which hold meetings once a month in the nearby town of San Juan Bautista Teacalco. Both men and women belong although there is a tendency for women to be more active in such associations. Membership is based on a personal decision and is considered to be of pragmatic value in stimulating better crops and affording some protection from disasters.

Social Organization - I have presented in Table 7 an analysis of the social composition of each residential complex of Maquixco and Colhuacan. The term true nuclear family refers to a social group in which both parents and the unmarried children are present. If any one of these components is absent the result is a partial nuclear family. Peripheral relatives consist of individuals related to one member of a true or partial nuclear family outside of the relationship of wife, husband or child. They do not form a true or partial nuclear family with any other individual, although they may have done so in the past. When any two types of nuclear family reside in the same complex and are related they form an extended family.

The analysis indicates a relatively high proportion of nuclear families and attenuated or partial nuclear families, both with some peripheral relatives present in a few cases. Lewis (1951: 59) remarked that in Tepoztlan "over seventy per cent of all house sites are occupied by the biological family". This is true for both Maquixco and Colhuacan. Extended families form a low percentage of the residential complexes and those which do occur tend to be married sons living with their father.

Economic Organization - I have classified both communities as rural since over 90% of the residential complexes (economic production and consumption units) of each village are maintained by activities directed toward the land. There are variations, however, in the nature of the participation of the complexes in this basic means of production. Other differences are to be found in the types of production activities supporting the residential complexes. I have summarized these in Tables 8 and 9. Due to secrecy and suspicion generated by requests for detailed information on the size of land holdings I could not obtain accurate information on that aspect of land tenure. The data presented in the two tables does indicate however that land holding is restricted to fewer residential complexes in Maquixco than in Colhuacan. This is accompanied by a decrease in occupations directly concerned with food production and an increase in occupations indirectly concerned with food production.

Table 7

RESIDENTIAL COMPLEX COMPOSITION

COMPOSITION	Col. No.	Col. %	Maq. Core No.	Maq. Core %	Periph. No.	Periph. %	C. Teclalo No.	C. Teclalo %	C. S. Jose No.	C. S. Jose %	C. Aguatepec No.	C. Aguatepec %
Nuclear Family (true)	27	47.3	28.	41.1	6	100.0	1	33.3	-	-	-	-
Partial Nuclear Family (one of F,M,Ch absent)	6	10.5	10	14.7	-	-	-	-	-	-	-	-
Nuclear Family and Peripheral Relatives	8	13.2	5	7.3	-	-	1	33.3	-	-	1	100.0
Partial Nuclear Family and Peripheral Relatives	5	8.7	6	8.7	-	-	1	33.3	-	-	-	-
Persons Living Alone	2	3.5	7	10.2	-	-	-	-	-	-	-	-
Extended Families (two or more true or variant nuclear families)												
Father; Married Son	5	8.7	7	10.2	-	-	-	-	1	100.0	-	-
Father; Married Daughter	2	3.5	1	1.4	-	-	-	-	-	-	-	-
Father; Two Married Sons	1	1.7	-	-	-	-	-	-	-	-	-	-
Father; Married Son and Married Daughter	-	-	-	-	-	-	-	-	-	-	-	-
Two Married Brothers	1	1.7	-	-	-	-	-	-	-	-	-	-
Two Married Sisters	-	-	-	-	-	-	-	-	-	-	-	-
Married Brother and Married Sister	-	-	-	-	-	-	-	-	-	-	-	-
Nuclear Family; Wife's Married Brother	-	-	-	-	-	-	-	-	-	-	-	-
Others												
Grandmother-Grandaughter	-	-	2	2.8	-	-	-	-	-	-	-	-
Aunt and Niece	-	-	2	2.8	-	-	-	-	-	-	-	-
Total	57	98.8	68	99.0	6	100.0	3	99.9	1	100.0	1	100.0

Table 8

Residential Complexes and Land Holdings

TYPE	COL.		MAQ. Core		MAQ. Periph.		Teclalo		S. Jose		Aguatepec	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No Lands	3	5.2	11	16.2	-	-	-	-	-	-	-	-
Ejido	26	45.6	31	45.5	4	66.6	2	66.6	1	100.0	-	-
Private	-	-	5	7.3	-	-	-	-	-	-	-	-
Pr. and Ejido	28	49.0	21	30.8	2	33.3	1	33.3	-	-	1	100.0

Table 9

Residential Complexes and Occupations

TYPE	COL.		MAQ. Core		MAQ. Periph.		Teclalo		S. Jose		Aguatepec	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A-DIRECT												
Campesino	36	63.0	43	63.2	4	66.6	2	66.6	-	-	1	100.0
Campesino and -molinero	1	1.7	-	-	-	-	-	-	-	-	-	-
-tienda	2	3.5	2	2.8	-	-	-	-	-	-	-	-
-jornalero	2	3.5	3	4.2	2	33.3	-	-	1	100.0	-	-
-obrero	3	5.2	1	1.4	-	-	-	-	-	-	-	-
-pastor	2	3.5	1	1.4	-	-	-	-	-	-	-	-
-albanil	1	1.7	2	2.8	-	-	-	-	-	-	-	-
-adobe	1	1.7	-	-	-	-	-	-	-	-	-	-
-tinacal	1	1.7	-	-	-	-	-	-	-	-	-	-
-tlachiquero	1	1.7	-	-	-	-	1	33.3	-	-	-	-
-jorn., obr., & tienda	-	-	-	-	-	-	-	-	-	-	-	-
-jorn., tinacal	-	-	-	-	-	-	-	-	-	-	-	-
-mol., tinacal	-	-	1	1.4	-	-	-	-	-	-	-	-
B-INDIRECT												
Jornalero	2	3.5	8	11.7	-	-	-	-	-	-	-	-
Jorn., Obrero	-	-	-	-	-	-	-	-	-	-	-	-
Jorn., Adobes	-	-	1	1.4	-	-	-	-	-	-	-	-
Pastor	-	-	1	1.4	-	-	-	-	-	-	-	-
Jorn., Albanil	1	1.7	-	-	-	-	-	-	-	-	-	-
C-OTHER												
Obrero	4.	7.0	-	-	-	-	-	-	-	-	-	-
Obrero, Mol.	-	-	-	-	-	-	-	-	-	-	-	-
Hogar	-	-	5.	7.3	-	-	-	-	-	-	-	-

Zonal Patterns

1. Geographic Patterns - San Cristobal Colhuacan is situated between 2500 and 2620 meters, on the north slope of Cerro Gordo. Most of the village sprawls along the eastern edge of the Barranca de San Cristobal (See Figures 7, 9). A few residences, most of which are unoccupied, along with the church, the school and the delegacion, are on the western edge. The residential complexes on the east are on a long ridge which derives directly from Cerro Gordo, while those on the west lie on the slope of Cerro Aguatepec.

The majority of the residences of Santa Maria Maquixco el Alto are located on the central section of the ridge which runs from Cerro Aguatepec to Cerro Tiquimil (See Figures 8, 9). Some outlying residences, both occupied and unoccupied are located in other parts of this ridge, and some are found on the ridge below Cerro Tezqueme and on the ridge which includes Cerros Teclalo and Tlacuache Grande. These complexes are oriented to barranca edges and hill slopes. All occupied areas lie above 2500 meters and below 2600 meters. The core area with the periphery reaches no higher than 2550 meters.

Maquixco and Colhuacan are two of many communities located in the region between the plain of Lake Xaltocan and the height of land on the northern edge of the Teotihuacan Valley. The communities tend to be located near the bases of hills to ensure an adequate water supply. They are widely dispersed through the region. All are small and with low population densities. Economically and politically they are subordinate to large communities located in the valley floor. I have listed characteristics of some of these communities in Table 10.

Table 10

CERRO GORDO-NORTH SLOPE COMMUNITIES

VILLAGE	POPULATION	Density PER KM^2	TYPE
Maquixco (core)	348	1,912	Rural
Colhuacan	306	1,090	Rural
Teacalco	812	1,320	Rural
Actopan	1,179	1,257	Rural
S. Pablo Xuchi	236	1,000	Rural
Sto. Domingo	687	1,100	Rural
S. Felipe Zacatepec	426	1,700	Rural

Note: All population figures are from the 1960 census.

2. Cultural Patterns - Colhuacan and Maquixco are linked with other communities in several ways. Politically both are included within the municipio of Temascalapa. This has its seat in San Francisco Temascalapa, a larger community (population in 1960, 1,649) located at the juncture of the upland region and the plain in the northern part of the Basin of Mexico.

Religiously Temascalapa also is of significance since the priest resides there and journeys out to deliver mass in the two communities. In addition, individuals go to Teacalco to attend meetings of religious associations which are centered there.

On October 29, the day of Cristo Rey, a mass is celebrated by the priest on the summit of Cerro Gordo. People come to this ceremony from Colhuacan, Maquixco, Temascalapa, Teacalco, San Bartolo, and Santo Domingo. The mass is held at a place named "el mogote". It is located within one hundred feet of a Toltec-Aztec pyramid that overlooks the Valley of Teotihuacan to the south.

It is in the area of economics that the most important connections with other communities exist. It is safe to say that these are the most significant ties members of the two villages have with other areas. Such ties are not restricted to the immediately adjacent pueblos but reach to Mexico City itself. This in part is a result of the construction of a new highway in 1958 which provided a good road to Tizayuca and bus service.

With the construction of the highway the growing of tunas developed in Maquixco as a commercial enterprise. Before then the tunas were grown on a small scale and consumed locally. This is still the case in Colhuacan and may be a result of the fact that only Maquixco has a good access road from the highway to the village.

There are two methods by which an individual may sell his tunas. If he has only a few he will transport these personally by bus to Mexico City to sell them directly. With a large crop it is usual for the owner to make contractual arrangements for the sale of the harvest as a unit to enterpreneurs from Mexico City or San Luis Tecuautitlan. The purchaser will then harvest the tunas and transport them by truck to the City.

Another product of the two villages that is sold in other communities is pulque. From Colhuacan pulque is taken twice a week to the town of Santa Isabel Iztapan located near the shore of Lake Texcoco. About two hundred liters are carried each trip by an "arriero" with a train of burros. The route follows a number of passes through the hills on the north edge of the Teotihuacan Valley and emerges near Tepexpan. The trip usually begins in the early afternoon and ends in the late evening. The arrieros stay overnight and return the next morning to Colhuacan. The pulque is sold for thirty centavos a liter and four hundred liters will yield an income of one hundred and twenty pesos a week.

A similar route was also used by people in Maquixco but has been abandoned with the building of the highway. Men from Colhuacan also transport pulque by burro to San Juan Teotihuacan, passing en route, the village of San Antonio de las Palmas and entering San Juan near the cuartel. It too was used by people from Maquixco in the past but no longer is followed.

With the building of the highway it has been possible to transport pulque by truck to Mexico City. Trucks from Temascalapa come to Maquixco and and occasionally Colhuacan for that purpose. Some individuals in Maquixco have purchased their own trucks to transport pulque.

Barley is the most important cash crop. It is sold in San Juan Teotihuacan, Temascalapa, or Tizayuca soon after threshing. An individual may transport it for him if he has a truck or truckers will come to transport it for them. Some maize is also sold, as are a few potatoes. Wool is sold to the people of Chiconcoac located near Texcoco. Sheep and goats are purchased on Thursdays and Fridays by men from Temascalapa to be sold as barbacoa in the Sunday market there.

The people of San Cristobal and Santa Maria purchase goods from diverse sources. A truck comes to both villages on Mondays loaded with vegetables and fruits to sell to the stores and to the private households. The local stores do not carry big stocks but usually have a few pots, some sandals, assorted fruits and vegetables at high prices, soft drinks, beer, and candies. In addition cigarettes are stocked. Soft drinks and beer trucks come regularly to replenish the supply in the local stores.

The people usually make most of their purchases once a week in the market at Temascalapa (Sundays). They also travel to more distant markets upon occasion, including Los Reyes Acosac (Thursdays), Tezontepec and San Juan Teotihuacan, (Mondays), Otumba (Tuesdays) and Mexico City (all days).

Special products are purchased from neighboring communities. These include fireworks for fiestas from San Luis Tecuautitlan, bricks and tiles from San Bartolo Actopan, and pots from San Felipe Zacatepec. As noted earlier some materials for house construction are purchased in Mexico City.

In addition to the ties already noted it should be mentioned that the two villages are linked with the immediately surrounding communities and with more distant communities through kinship and the compadrazgo relationship. I did not have time to examine either ot these in detail and can only mention them here. Due to recent migration from both Colhuacan and Maquixco to Mexico City many families have relatives there. Some of the migrants from Colhuacan are centered in Xalostoc, a former peasant village that has become a northern suburb of the city.

Table 11 summarizes information about native born and non-native born over fifteen years of age.

Table 11

POPULATION ORIGINS

VILLAGES	Native Born No.	%	Non-Native Born No.	%
Sn. Cr. Colhuacan	156	87.7	22	12.3
Sta. M. Maquixco				
Core	145	83.8	28	16.2
Periphery	11	57.8	8	46.2
Colonias:				
Teclalo	7	77.7	2	22.3
S. Jose	4	66.6	2	33.3
Aguatepec	3	100.0	-	----

In each village the members of the population who were born in other communities tend to be either spouses who moved to the village or persons who came to live there after the break-up of the haciendas.

Summary - Thus it is readily seen that although the communities on the north slope of Cerro Gordo may seem to be isolated they are participating in interrelations with many different communities.

THE UPPER TEOTIHUACAN VALLEY

The Area

The Upper Valley lies within the north-eastern part of the Teotihuacan hydrographic basin. It is an area which has not been carefully studied in terms of boundaries and settlement patterns. Gamio did not include the Upper Valley within his survey and referred to it as the Valley of Otumba (1922, T. II: 85). It was first referred to as the Upper Valley by Sanders (1957: 103-104). Sanders considers it to be one of several ecological zones within the Teotihuacan Valley and has defined and described the area in his 1965 publication in the following manner.

> 1. Upper Valley - From San Pablo Isquitlan to Xaltepec. The town of Otumba is located in the center of this division of the Valley within a small oval depression of deep soil. The soil ranges from 50-200 cm. in depth and the depression has a diameter of two to three kilometers. Surrounding this core of deeper soil to the north, east and south is a band of gently sloping piedmont with thin soil, approximately 10 km. in width. To the north and northeast this piedmont is delineated by a few low hills, to the south and southwest by foothills of the northern terminus of the Sierra Nevada or by the Patlachique Ranges. The Upper Valley is the most unfavorable area for agricultural exploitation today. Barranca runoff is abundant only to the south and even there the hills are so far from the deep soil core and so deeply eroded that very little floodwater irrigation is possible. Nearly all cultivation is "temporal" (i.e., based on rains) and it is primarily a zone of maguey cultivation. There are small, deep soil flood plains along the barrancas to the south that alleviate the problem somewhat, but the total acreage is small. A special local resource other than agriculture in this area for the pre-Hispanic Period would be obsidian. (1965: 25-26).

In this paper the Upper Valley is defined as the area being east of a line drawn from Santiago Tolman on the north to Santiago Tepetitlan on the south. By doing so a number of communities (Santiago Tolman, Santiago Tepetitlan, Belen and Oxtotipac) are included which Sanders and Diehl have placed in the Middle Valley.

Community Patterns

Sanders (1957) did the first study of settlement patterns within the Upper Valley. In 1963 Richard Diehl carried out surveys within the communities of Axapusco, Otumba, Belen and Santiago Tepetitlan. I carried out a detailed study of the settlement pattern of San Pablo Isquitlan during the spring of 1964. Sanders had previously worked in San Pablo in 1954 (1957). In addition I have visited the majority of the communities in the Upper Valley during archaeological survey in the area (1963, 1966).

1. Houselots

General - A detailed study of the houselots in San Pablo Isquitlan and observations in other communities in the Upper Valley indicate that here, as on the

north slope of Cerro Gordo, the nucleus of each residential complex consists of two basic structures, the cuarto (living room) and the cocina (kitchen). Two separate structures are usual although one room may be both cuarto and cocina. When two units are present they are physically close, the cocina often being built against one wall of the cuarto.

Cuartos and cocinas are usually rectangular in shape although they may also be square. Roof types vary in frequency depending upon the community and the individual house owner but plano roofs are most common, with boveda and cuchillo roof types occurring infrequently. Windows are uncommon in most communities and chimneys are absent.

The presence or absence of other structures within a houselot is similar to the situation on the north slope of Cerro Gordo. Additional structures, which serve different functions, are frequently associated with cuarto and cocina in a residential complex. Any such complex may include some or all of the following units; pig pens, corrals, macheros, turkey and chicken coops, and temascales. Extra cuartos are used as storage rooms, tinacales, tiendas and molinos in some complexes. The presence of any of the above structures depends upon the economic status of the residential group, as reflected in the possession of animals, and in participation in non-agricultural subsistnece activities. Older complexes tend to have a greater variety of structures associated with them.

San Pablo Isquitlan - In San Pablo the units within the residential complexes are so arranged as to fall within the two major types of residential complexes described for Maquixco Alto and Colhuacan. There are forty-six formal enclosures within the village out of a total of seventy-nine residential complexes. These have the usual surrounding walls of brick, adobe or stone with one or two doorways to the huerta or the street. The component units face the enclosed corral-patio. The other residential complexes are tightly arranged with the units facing each other across a small patio, their blank walls turned to the streets and the lot edges. Twenty-four out of these remaining complexes are also densely surrounded by vegetation such as nopals, magueys, trees and organ cactus, to obscure the view. Six complexes, although tightly arranged, have no surrounding vegetation. Three complexes within the village were too badly destroyed to determine their precise nature.

There is a tendency for formal enclosures and informal, but obscured, complexes to be centrally located with open complexes peripheral to the village. The walled compounds are usually more central than the obscured complexes. However, each type occurs in every part of the village.

Other Upper Valley Communities - Although no detailed studies have been carried out in other communities in this area, many of the communities have been visited by Diehl and Charlton and general types and disposition of residential complexes noted. The following table indicates general impressions of the house complexes and their distribution. Also listed are the detailed figures for San Pablo Isquitlan.

Table 12

TYPES OF RESIDENTIAL COMPLEXES

COMMUNITY	WALLED	OBSCURED	OPEN	UNKNOWN
SAN PABLO ISQUITLAN (out of village area)	43-3*	22-2*	6-0* 0-2*	0-3* 0-5*
SANTIAGO TOLMAN	a few	majority	a few	(* = unoccupied.)
Sta. M. CHOLPA	--	majority	a few	
Sta. CRUZ TLAMAPA	a few	majority	a few	
AXAPUSCO	ca. 33.3%	ca. 66.6%	a few	
OTUMBA	ca. 50%	ca. 50%	--	
Sn. MARTIN AGUATEPEC	a few	majority	a few	
SAN MARCOS	a few	majority	a few	
Sta. M. BUENAVISTA	--	ca. 50%	ca. 50%	
POYOXCO	--	majority	--	
Sta. M. TLALMIMILOLPA	--	majority	--	
TOCUILA	--	majority	--	
Sn. MIGUEL XOLCO	--	majority	--	
Sn. FRAN. TLALTICA	--	majority	--	
OXTOTIPAC	a few	majority	--	
BELEN	a few	majority	a few	
SANTIAGO TEPETITLAN	a few	majority	a few	
CUAHUTLAZINGO	a few	majority	a few	

2. House Construction

General - The pattern in use of materials in the Upper Valley is very similar, if not identical, to that on the north slope of Cerro Gordo. Materials vary with the age and function of a unit as well as well as with the village. Although several different construction materials are usually present and at times incorporated within a single unit, one material tends to dominate.

Cuartos, cocinas, macheros and temascales are built of the most durable materials. Other structures make use of such items as maguey pencas, thatch and poles.

San Pablo Isquitlan - Adobe is the material most frequently used to construct cuartos, cocinas, macheros, tiendas, tinacales and molinos in San Pablo. Forty-eight of the eight-six residential complexes are composed entirely of structures

of adobe. In addition adobe buildings are associated with structures of other materials in thirty-three other complexes. The other materials used are brick, stone and tepetate. Occasionally xalnene is incorporated into a structure but is rarely used alone. Reinforced concrete vertical corner posts are occasionally associated with adobe walls.

As in Colhuacan and Maquixco there is a definite tendency to build the cocina out of less durable materials, such as pencas and thatch. This occurs in six residential complexes of San Pablo. Furthermore the other associated structures mentioned are frequently constructed of less substantial materials. Temascales, which occur in four complexes, are always built of stone.

The most common roof type in San Pablo is the plano roof, present alone in sixty-four complexes, combined with boveda roofs in thirteen, and with cuchillo roofs in four. Boveda roofs occur alone only in five complexes. Roofing materials vary with flat tiles or bricks (tabiques) associated with boveda roofs and cylindrical tiles, asbestos, tarpaper, corrugated tin, wooden slats and maguey pencas associated with plano and cuchillo roof types. Tables 13 and 14 indicate the frequency of occurrence of the various building and roofing materials and roof types in the residential complexes of San Pablo.

Table 13

CONSTRUCTION MATERIALS-SAN PABLO ISQUITLAN

WALL MATERIALS	RESIDENTIAL UNITS FOUND IN No.	%
Adobe	48	55.6
Brick	4	4.6
Tepetate	1	1.1
Adobe and Stone	4	4.6
Adobe and Tepetate	4	4.6
Adobe and Brick	22	25.6
Adobe, Brick, Tepetate	3	3.4
TOTALS	86	99.5

Table 14

ROOF TYPES AND MATERIALS-SAN PABLO ISQUITLAN

MATERIALS	NO.	%
Round Tile	27	31.4
Round Tile &		
-Asbestos	12	13.9
-Tarpaper	8	9.3
-Tencas	2	2.3
-Asbestos &		
Tarpaper	3	3.5
Tin & Tarpaper	2	2.3
Tarpaper	7	8.1
Wood slats	1	1.1
Flat Tile	5	5.8
Flat Tile &		
-Tarpaper	1	1.1
-Round Tile	8	9.3
-Round Tile &		
Tarpaper	4	4.6
& Unknown	6	6.9
TOTALS	86	99.6

ROOF TYPES	NO.	%
Plano	64	74.4
Plano-Cuchillo	4	4.6
Plano-Boveda	13	15.1
Boveda	5	5.8
TOTALS	86	99.9

The community buildings, church, school and delegacion, are built of stone. Interior and exterior walls of the church and delegacion are plastered and painted. The new school is being constructed of stone but will probably not be plastered since the masonry is being finished with great care. Plastering and painting also occur on the walls of structures located near the plaza. This type of treatment is more common in San Pablo than in Maquixco or Colhuacan though not as common as in Otumba.

Materials used in construction are either manufactured in the village or purchased from neighboring communities. According to my informants all men know how to make adobes. This is done during the dry season. In the unlikely eventuality that a person wishing to build an adobe house does not know how to make the basic materials he will get someone who knows how to help him. They are rectangular and mold-made. Mud mortar is made by the builder during construction. Stone, which is used for bases for adobe walls, is purchased from quarries in the lands

of Santiago Tolman to the north, and, according to some informants, from the village of Xometla in the Lower Valley. Tepetate and xalnene, as well as tezontle for plaster can be obtained from the hillslope lands of San Pablo. Dead magueys provide pencas for roofing. Brick and tiles are bought in Axapusco. Corrugated tin, asbestos and tarpaper may be purchased in Otumba or in Mexico City. Reinforcing rods and concrete are bought in Mexico City. There is a tendency here, not present to the same degree in other communities more isolated from main highways, for new structures to be built of brick and reinforced concrete.

Two men in the village are recognized as part-time masons and when construction is undertaken they are frequently called in to help. Most men, however, have some basic knowledge about house construction. The owner of a house usually constructs it. My work at San Pablo was carried out during the rainy season and no houses were under construction at that time. However, from my observations on ruins and incompleted houses it is possible to say that construction procedures are virtually identical to those described for Maquixco Alto and Colhuacan.

Floors of houses are usually of earth although in some of the more recently constructed complexes concrete floors appear. Windows are usually absent but when they are present they consist of small panes of glass fitted into a metal frame, the latter purchased in Mexico City.

Figures 10 and 11 illustrate the enclosed compound and the obscured complexes, prevalent in San Pablo Isquitlan.

Santiago Tepetitlan - Diehl has collected data on house materials, roofing materials and roof types from this community. Of a total thirty-four buildings (residential complexes) he examined, fourteen were built entirely of stone, eight entirely of adobe and ten of both materials. He noted construction features of twenty-nine roofs. Of these twenty-six were plano and three were boveda in style. Cylindrical tiles and lamina (usually corrugated asbestos or tarpaper) were the most common roofing materials present on plano roofs with flat tiles on the boveda roofs. This information is summarized in Tables 15 and 16 along with general impressions on construction materials, roofing materials and roof types in other communities in the Upper Valley.

Table 15

CONSTRUCTION MATERIALS-UPPER VALLEY

COMMUNITY	WALL MATERIALS	NO.	%
SANTIAGO TEPETITLAN	Adobe	8	23
	Brick	1	3
	Stone	14	41
	Penca	1	3
	Adobe & Stone	10	30
SANTIAGO TOLMAN	Stone	Major	
	Adobe	Minor	

Table 15 - Continued

COMMUNITY	WALL MATERIALS	NO.	%
Sta. CRUZ TLAMAPA	Stone	Major	
	Adobe	Minor	
AXAPUSCO	Stone	Major	
	Adobe	Minor	
OTUMBA	Stone	Major	
	Adobe	Minor	
Sn. MARTIN AGUATEPEC	Stone	Major	
	Adobe	Minor	
SAN MARCOS	Stone	Major	
	Adobe	Minor	
Sta. M. BUENAVISTA	Stone	Major	
	Adobe	Minor	
POYOXCO	Stone	Major	
	Adobe	Minor	
Sta. M. TLALMIMILOLPA	Stone	Major	
	Adobe	Minor	
TOCUILA	Stone	Major	
	Adobe	Minor	
Sn. MIGUEL XOLCO	Stone	Major	
	Adobe	Minor	
Sn. FRAN. TLALTICA	Stone	Major	
	Adobe	Minor	
OXTOTIPAC	Stone	Major	
	Adobe	Minor	
BELEN	Stone	Major	
	Adobe	Minor	
CUAHUTLAZINGO	Stone	Major	
	Adobe	Minor	

Table 16

ROOF TYPES AND MATERIALS-UPPER VALLEY

TOWN	PLANO No. %	BOVEDA No. %	CYLINDRICAL TILE No. %	LAMINA No. %	FLAT TILE No. %
SANTIAGO TEPETITLAN	26-90	3-10	18-62	8-28	3-10
SANTIAGO TOLMAN	major	minor	major	minor	minor
Sta. CRUZ TLAMAPA	major	minor	major	minor	minor
AXAPUSCO	major	minor	major	minor	minor
OTUMBA	ca. 60%	ca. 40%	ca. 50%	ca. 10%	ca. 40%
SAN MARTIN AGUATEPEC	major	minor	major	minor	minor
SAN MARCOS	major	minor	major	minor	minor
Sta. M. BUENAVISTA	major	minor	major	minor	minor
POYOXCO	major	minor	major	minor	minor
Sta. M. TLALMIMILOLPA	major	minor	major	minor	minor
TOCUILA	major	minor	major	minor	minor
Sn. MIGUEL XOLCO	major	minor	major	minor	minor
Sn. FRAN. TLALTICA	major	minor	major	minor	minor
OXTOTIPAC	major	minor	major	minor	minor
BELEN	major	minor	major	minor	minor
CUAHUTLAZINGO	major	minor	major	minor	minor

Summary - Houselots and House Construction in the Upper Valley

Walled residential compounds tend to be associated with communities which have high population densities within the occupied residential area. Municipal centers such as Otumba and Axapusco have a greater frequency of this type of residential complex than do other communities with little political importance. In general such walled complexes are centrally located within a community.

Obscured and open residential complexes are found in all communities but their greatest frequency is in those with low internal population densities and in those which are more isolated from external contacts. In communities with high internal population densities the obscured and open residential complexes tend to occur on the periphery. Diehl (1966) has noted similar distributions of residential complexes in the Lower and Middle Valley.

The dominant roof type in rural communities is the plano roof. Although the cuchillo and boveda roofs do occur in such communities they are not frequent. Boveda roofs are more common in communities closer to main routes of transportation, and in those communities which are more urbanized in internal settlement pattern.

The major dichotomy in materials used in house construction lies in the emphasis on adobe in communities located on the plain and on stone in communities located in the piedmont and hillslope areas of the Upper Valley. No community uses exclusively any one material. The prevalence of one material is a reflection of its availability. The use of materials such as bricks, reinforced concrete, corrugated tin, asbestos and tarpaper, in house construction varies with the location of the community vis a vis transportation and the economic status of the owner.

3. The Community

General - Although there are variations in the frequency of occurrence of residential complexes and construction materials the communities of the Upper Valley participate in a single tradition of house type and construction. They vary, however, in the arrangement of the residential complexes within the occupied area, and in the presence or absence of all or some of the elements of the plaza-church-delegacion-school complex.

In the Upper Valley the settlement pattern of only one community, San Pablo Isquitlan, was studied in detail. The area occupied by the village (See Figure 12) was determined by including all occupied lots (solares), occupied and cultivated lots (huertas) and cultivated adjacent lots considered as huertas de campo by the inhabitants. By following this procedure a single residential area for San Pablo was established. Using air photos the occupied areas of a number of other communities in the Upper Valley was approximately determined. Diehl studied Santiago Tepetitlan in 1963 and some of his data is included here.

In Table 17 the detailed data on residential complex occupation within San Pablo is summarized. Unfortunately comparable data are available only for the north slope of Cerro Gordo. Table 18 summarizes population density per residential complex and km^2 within the sample communities. Not all communities are included since there is a discrepancy between some of the local names and those referred to in the Census data of 1960.

Table 17

SAN PABLO ISQUITLAN - VILLAGE AREA AND RESIDENTIAL UNITS

AREA		UNITS		DENSITY
10.00 hectares	71	8*	7*#	7.10 per hectare

* denotes unoccupied
\# denotes located outside town area

Table 18

UPPER VALLEY-COMMUNITY DENSITY

COMMUNITY	POPULATION(1960)	PER UNIT	PER KM^2
POYOXCO	8	--	12
Sta. M. TLALMIMILOLPA	40	--	106
Sn. MIGUEL XOLCO	124	--	124
TOCUILA	79	--	158
Sn. FRAN. TLALTICA	544	--	290
Sta. M. BUENAVISTA	369	--	492
Sn. MARTIN AGUATEPEC	569	--	503
AXAPUSCO with EJIDO Sn. ANT. OMETUSCO	1270	--	508
CUAHUTLAZINGO	931	--	580
OXTOTIPAC	684	--	684
SAN MARCOS	851	--	851
Sta. M. CHOLPA	227	--	908
TECUAUTITLAN	281	--	1,497
SANTIAGO TOLMAN	1567	--	1,567
SANTIAGO TEPETITLAN	536	6.32	2,036
XALTEPEC	1406	--	2,038
BELEN	988	--	2,232
OTUMBA	1919	--	2,558
SAN PABLO ISQUITLAN	476	6.90	4,760
(1964)	500	7.00	5,000

*Avg. per unit based on sample of 34 residential units with 215 occupants.

Excepting only Otumba and Axapusco all of the above communities in the Upper Valley may be considered non-urban in character. Utilizing Sanders' definition of community types in the Teotihuacan Valley they may be classified as follows.

Compact Rancherias - Included in this category are all those communities with an internal population density less than 500 persons per km^2. Using the 1960 census data the internal population density of Poyoxco is so low that theoretically it might be classified as a true rancheria. However, on the basis of my own

observations in 1966 I believe that the 1960 census data are incorrect and do not include the total population of this settlement. Sanders has defined a Compact Rancheria in the following manner.

> . . . A feebly defined residential zone exists in this type, but the houses are very widely spaced with much intervening agricultural land. The densities of the several test cases averaged around 200-300 per km^2--much too high for a true rancheria (if located on the eroded piedmont of the valley), but so dispersed that one hesitates to call such communities nucleated. This is a very rare settlement type in the valley. (1965: 50).

Within the six communities the low internal population density is reflected in the widely spaced residential complexes with no clustering or contact present. In two of the communities, San Francisco Tlaltica and San Miguel Xolco, there is some evidence of community planning with several straight streets crossing at right angles. Such planning is not consistently applied. The other four communities, Poyoxco, Santa Maria Tlalmimilolpa, Tocuila and Santa Maria Buenavista lack any such planning. In all communities crops are planted between the residential complexes.

Tocuila and Poyoxco lack all community structures. Buenavista has a school building and Tlalmimilolpa has a small, recently constructed church. San Francisco Tlaltica and San Miguel Xolco also have churches. Well defined plazas are absent from all communities.

Scattered Villages - Communities with internal population densities between 500 and 1000 persons per km^2 are included within this type of settlement. There are five such rural communities in the Upper Valley. Sanders has defined it as follows:

> . . . A very common type of community in the area. It differs from the Compact Rancheria in that most of the agricultural land is located outside the village. Houselots, however, are large, usually planted in maguey or nopal but not infrequently in grain crops. Also, empty cultivated fields frequently occur dispersed through the settlement area. Such settlements very rarely have regular street grids. The density varies from 500-1000 per km^2. (1965: 50).

Although this type of community has an increased population density the residential complexes still tend to be separate units with few cases of units coming into physical contact with adjoining walls. Slight clustering of residential complexes occurs in each of the communities but is most pronounced in Santa Maria Cholpa (Xalmimilolpa). All communities have some straight streets which cross at right angles but community planning is not consistently applied in any of them. All have plazas with churchas associated. In Oxtotipac the church has an associated 16th century convento. I have noted schools in Oxtotipac, Cuahutlazingo, San Marcos, and San Martin Aguatepec.

Compact Low-Density Villages - Five rural communities in the Upper Valley fall into this category of settlement type defined by Sanders.

> . . . Numerous villages in the valley have densities ranging from 1000-2500 per km^2. Many houselots have maguey or nopal orchards

> or stalls for domestic animals but the houselots are smaller than in Scattered Villages and grain cultivation is rare. Regular street grids are more common in these communities than in Scattered Villages. (Sanders, 1965: 50)

Only two of the five communities included in this category in the Upper Valley have regularly applied grid plans. These are Tecautitlan and Xaltepec. The others, Santiago Tolman, Santiago Tepetitlan and Belen have plans very similar to the Scattered Villages described previously. Diehl has described both Belen and Santiago Tepetitlan.

The residential complexes within Tepetitlan are constructed on a series of terraces. They are widely spaced, each being surrounded by land planted in maize or nopal. The density of residential structures increases toward the center of the community. The paths which connect the various residential complexes are not straight but conform to the topography of the area occupied by the community. A small church and a school building are located within the community.

Belen also has widely spaced houses located within planted fields in the residential area of the community. Nopal is a major cash crop and is generally planted around the residential complexes. The streets and/or paths linking the units are not straight but curve to the contour of the hillslope. A small plaza, church and school are present in the town.

Santiago Tolman has a similar pattern of widely spaced residential complexes, enclosed in fences consisting of various types of cacti. Streets and paths generally curve to fit the contour of the slope although some straight streets occur. The community has a two story town hall, a new stone school, a church and a plaza.

Unfortunately the author has never visited Xaltepec or Tecuautitlan and cannot comment further on them. The communities included within this category of compact low-density villages are very similar to the core area of Maquixco Alto described earlier in this paper.

High Density Compact Villages - Only one community, San Pablo Isquitlan, falls into this category in the Upper Valley. Sanders has defined this category to include:

> . . . Densely nucleated communities with small houselots occupied primarily by residences and courts and with very little agricultural activity in the residential zone. Regular street grids are common. Densities range from 2500-5000 per km^2. (1965: 50)

Within San Pablo Isquitlan thirty-one of the total seventy-nine residential complexes in the village are separate, non-contiguous complexes. The rest are in physical contact with at least one of their neighbors. Often a solid facade completely enclosing a single block is formed by these complexes. For the most part the separate complexes are new and on the fringes of the occupied area.

In San Pablo the grid plan serves as the major reference for the location of residences. Houses are customarily constructed on the edge of the street.

A few are in the centers of huertas or along the barrance edge. The residential complexes tend to cluster in the blocks near the plaza where several two story structures occur. In addition there is some clustering along the main street leading to the highway. Mills and tiendas are situated within residential complexes.

The village has a well defined plaza with a church and a school. In 1964 a new school was under construction along the highway. The area around the plaza is the most heavily occupied part of the village. In this zone there are virtually no crops present. Of the ten hectares included within the community area, five are under cultivation, usually with maize, some nopals and some fruit trees. The central core of the village is that part devoted to public buildings, streets and solars without crops. It is quite unlike the other types of rural communities already described for the Upper Valley. Actually San Pablo Isquitlan is, in physical appearance, very similar to the more urbanized communities of the Teotihuacan Valley, such as Otumba and San Juan Teotihuacan. Other features, however, tend to differentiate high density compact villages from urban and incipiently urban communities.

Urban Settlements-Towns

Within the Upper Valley there are two communities, Otumba and Axapusco, which may be considered urban and incipiently urban respectively. According to Sanders the incipient urban status of Axapusco derives from its political rank as cabecera of a municipio (1965: 49). Otumba, on the other hand, is definitely a town with urban characteristics well defined. It, too, is cabecera of a municipio.

Sanders has defined a town in the following manner:

> . . . a rural community in which most of the population are subsistence farmers but where trade and craft specialization are added as secondary activities reducing the percentage of the population dedicated to agriculture to below 75%. In Mexico, most communities classed as towns are usually municipal centers and in general are larger in population than villages. All towns measured have population densities exceeding one thousand per square kilometer. (1963: 16)

Axapusco - Although I have suggested an internal density of 508 persons per km^2 for Axapusco it should be indicated that in the central portion of the community around the plaza this density increases to between 1000 and 3000 persons per km^2. In this area the residential complexes are quite close to each other and frequently touch. Away from the center, however, the houses are quite widely dispersed and separated by cultivated fields.

There is evidence for the consistent application of a grid plan over the entire town area. This is most closely adhered to in the central area although it extends into the more lightly occupied peripheral sections. Houses tend to be oriented with reference to this plan.

Axapusco has a centrally located plaza. Associated with the plaza are a number of structures including a large church, a municipal palace (palacio municipal), a Catholic primary school, a priestly seminary, a number of stores,

and a maize grinding mill. A new public, primary school is located just east of the town and the Patronato del Maguey, which was inaugurated in 1964 but not functioning in 1966, is south of the town on the highway to Otumba. The church is quite large and very ornate. Aside from being a cabecera of a municipio Axapusco is also a parish seat with a resident priest.

Otumba - I have estimated an internal population density for Otumba of 2558 persons per km^2. As in Axapusco, however, there is a tendency for a heavier concentration of persons around the central part of the town which would raise the density in that area closer to 4000-5000 per km^2.

In the area around the plaza and in the blocks surrounding the plaza the residential and commercial units are quite close, forming single facades which enclose entire blocks. Away from the center there are more separate residential complexes but even these are quite close to each other, maintaining a density which is close to 2000 persons per km^2.

Otumba, lika Axapusco, has a grid plan which serves as a reference point for the location of residential complexes. It is more closely adhered to in the center but still is important throughout the entire town.

Around the plaza there are many community and commercial structures. These include a large church which is elevated above the plaza on the east and which physically dominates it, a hotel and the palacio municipal. In addition there are a number of restaurants, bars, butcher shops, stores, drug stores, and maize grinding mills in the area around the plaza as well as extending into the surrounding blocks. At least two doctors have offices on or immediately off the plaza. A newspaper stand, an automobile parts store and a poolroom are also found on the plaza. In the palacio municipal there is a state police barracks. Near the plaza is a telegraph office. The primary school is located in a block to the east of the plaza. Otumba has a resident priest and is a parish seat.

Summary - Similarities and Differences in Community Patterns

The communities patterns of the Upper Valley communities vary in a number of significant features. The most clear-cut difference lies in internal population densities which range from a possible 12 per km^2 to 5000 per km^2. These are also related to the density of residential complexes within communities although specific data is available only for San Pablo Isquitlan. Also linked to population densities are types of residential complexes. Given a desire for privacy the increase in frequency of walled complexes associated with high internal population densities is not too surprising. A similar tendency was noted on the north slope of Cerro Gordo. Contiguous units also increase with population density in a community.

The presence or absence of a formal plan is also related to the population densities within the communities but does not depend entirely on them. This is true also of specialized community and commercial structures which have a differential rate of occurrence in the communities of the Upper Valley. It is probable that those factors which determine internal population and residential unit densities also affect to some degree the occurrence of plans and specialized buildings.

Crop distribution within communities and the types of crops grown in a residential area are directly related to population and residential unit densities. Increased densities reduce crop productivity and available land for cultivation resulting in the differences noted.

In the Upper Valley, as on the north slope of Cerro Gordo, an explanation of factors producing differences in population and residential complex densities within communities would account for other variations in community patterns. A related problem concerns the present distribution of grid plans in communities of the Upper Valley.

In the following sections I shall examine a number of factors which could influence the formation of community patterns in the Upper Valley and indicate those which I consider to be significant.

Agricultural Technology, Environment and Population - With the exception of the research carried out by Sanders (1957) and myself which is summarized in the paper on contemporary agriculture in the Teotihuacan Valley no detailed studies of agriculture are available for the Upper Valley. In general the area has a very low productivity due to thin soils, heavy erosion and limited water for floodwater irrigation. However, particular microgeographical areas may have higher productivity.

San Pablo Isquitlan, Santiago Tolman and Cuahutlazingo participate to some extent in floodwater irrigation. Data from San Pablo suggest very high productivity through the use of this technique. To the south, on the edges of the Patlachique Range, Santiago Tepetitlan and Belen have both terraces and presas which also give higher crop yields. The rest of the area, including the Otumba plain, the long ridges and the piedmont, is under temporal cultivation. The higher mountain slopes are used for pasture.

Although several communities within the Upper Valley do participate in agricultural systems with higher productivity there is no correlation between this and their internal population densities. San Pablo Isquitlan, Cuahutlazingo and Santiago Tolman use lands which include hillslope, piedmont and plain. Agircultural emphasis is on the deep soil plain with a floodwater irrigation system. Despite this, the internal population densities are quite different ranging from 580 per km^2 for Cuahutlazingo, to 1567 per km^2 for Santiago Tolman to San Pablo's 5000 per km^2.

Further data from the north slope of Cerro Gordo compared with similar data for San Pablo Isquitlan suggest no correlation between internal population densities and the productivity of agricultural systems as indicated by the number of persons supported per km^2 of cultivated land.

The lower productivity of the lands of Maquixco Alto and Colhuacan is reflected in the fewer persons supported per km^2 of cultivated land. As might be expected the lands of San Pablo support a larger number of persons per km^2 of cultivated area. Unfortunately similar data are not available for the other communities in the Upper Valley and I must extrapolate from those which are available. My comments apply to the Upper Valley communities and the Cerro Gordo-North Slope communities.

Table 19

CULTIVATED LAND AND POPULATION DENSITIES

VILLAGE	TOTAL LANDS	CULT. LANDS No.	CULT. LANDS %	DENSITY PER KM^2 CULT. LANDS	DENSITY PER KM^2 INTERNAL
Sn. Cristobal Colhuacan	1148	311	27.0	102	1153
Sta. Maria Maquixco	1349	411	32.3	94	2044
San Pablo Isquitlan	599	373	62.3	134	5000

NOTE: (a) Cultivated lands of Colhuacan and Maquixco include an estimated 25% of ejido lands.

(b) The population density for Maquixco is for the core area of the village.

(c) The cultivated lands of San Pablo include an estimated 10% of the hillslope hacienda lands.

(d) Detailed data on land holdings for these three towns appear in the paper on Contemporary Agriculture.

(e) All areas are in hectares; all densities are per km^2.

One of the most prevalent explanations of variations in density in community patterns is based on differences in the interaction of agricultural technology and environment. It has been postulated that differences in either or both create differences in agricultural productivity which in turn influences both population size and concentration within a community.

It would appear that any differences in the crop production of a rural community will increase or decrease the number of persons potentially able to survive within the area being exploited. However, there is no necessary correlation between such productivity and the internal population densities of a community or the residential complexes of a community. The manner in which people arrange their residential units within a community does not depend directly on agricultural productivity although the total population supported within a given area does depend on productivity.

All the villages under consideration share similar agricultural techniques, technology and knowledge. Their environments do differ. The higher productivity of the exploited environment of San Pablo compared to that of Maquixco Alto and Colhuacan is reflected in the population supported per km^2. The lower population supported by the lands of Maquixco and Colhuacan reflects a generally lower productivity in that area.

Even if the population of Maquixco or Colhuacan were increased to that of San Pablo, the population and residential complex densities would not be as great as they are in San Pablo Isquitlan. The differences between the three villages are not merely differences in total populations, but rather

differences in the arrangement of each population and its residential complexes within the environment. The population and residential units of San Pablo Isquitlan are definitely concentrated in a smaller area than those of Maquixco or Colhuacan. In addition there are more persons per residential unit in San Pablo. These differences in arrangement do not depend upon total population within each community but upon the organization of each population in its exploitation of the environment. Differences in total population depend on the environment and agricultural technology; differences in internal population and residential unit densities depend on other factors.

Although detailed data on agricultural productivity for other communities in the Upper Valley is not available there is probably no correlation between such productivity and variations in the internal density of population or residential complexes in any of the community types discussed earlier.

Political Organization - In Table 20 the political affiliations of each community in the Upper Valley have been indicated along with the political categories designated in the 1960 census.

Table 20

POLITICAL ORGANIZATION-UPPER VALLEY

MUNICIPIOS AND COMMUNITIES	POLITICAL CATEGORY	COMMUNITY TYPE
Municipio of Otumba		
Otumba (cabecera)	Ciudad	Town
San Martin Aguatepec	Pueblo	Sc. Village
Belen	Pueblo	Com. Lo. D. Village
Sta. M. Buenavista	Rancheria	Comp. Rancheria
Cuahutlazingo	Pueblo	Sc. Village
Oxtotipac	Pueblo	Sc. Village
Poyoxco	Rancheria	Comp. Rancheria
San Francisco Tlaltica	Pueblo	Comp. Rancheria
San Marcos	Pueblo	Sc. Village
San Miguel Xolco	Pueblo	Comp. Rancheria
Santiago Tolman	Pueblo	Comp. Lo. D. Village
Sta. M. Tlalmimilolpa	Barrio	Comp. Rancheria
Tocuila	Rancheria	Comp. Rancheria
Sta. M. Xalmimilolpa (Cholpa)	Barrio	Sc. Village
Municipio of Axapusco		
Axapusco (cabecera)	Pueblo	Town
Xaltepec	Pueblo	Comp. Lo. D. Village
Tecuautitlan	Ejido	Comp. Lo. D. Village

Table 20-Continued

MUNICIPIOS AND COMMUNITIES	POLITICAL CATEGORY	COMMUNITY TYPE
Municipio of San Martin		
San Pablo Isquitlan	Pueblo	Hi. D. Comp. Village
Santiago Tepetitlan	Pueblo	Comp. Lo. D. Village

In the Upper Valley as on the north slope of Cerro Gordo the political organization of communities is imposed by the State and Federal Governments. There are few data available on the amount of participation in the municipio government by members of each community. Data from San Pablo Isquitlan suggest that this community is relatively active politically, sending a regidor regularly to San Martin.

Within the community the offices prescribed by the government are filled by individuals elected to the particular positions. The political organization of San Pablo was not studied in depth but there do not appear to exist any other political structures except that which is officially sanctioned by higher governmental authorities. An examination of those individuals who hold or have held political office in Maquixco Alto, San Cristobal and San Pablo indicated no relation between office holding and residential complex type or location. Individuals who held offices lived in all parts of the villages and were of all economic strata.

There is not a close relation between the community type as used in this paper and the political classification of the community by the government. It should be pointed out that the cabecera status of Otumba and Axapusco may account for the presence of urban and incipiently urban traits in the two communities as seen in the varied types of structures present compared with other communities. This political status is not related significantly to internal population density or residential unit density. San Pablo Isquitlan, a pueblo, has a greater internal density of residences and population than either of the cabeceras in the Upper Valley.

There is a tendency for communities classified as pueblos to have at least a partial application of an orderly plan. This is frequently absent in those classified as rancherias. In addition a plaza with community structures is frequently found in pueblos as opposed to rancherias.

The presence and absence of orderly plans and specialized community and commercial structures tend to be correlated with the official political status of the particular community. However, the political status of a community, rural or urban, does not alone account for the internal population and residential complex densities within the community.

The conclusions suggested here on the lack of significant correlations between intra-community densities of residential complexes and population and

political organization apply also to the communities on the north slope of Cerro Gordo. Data from those communities as well as from the Upper Valley have been used in reaching these conclusions.

Religious Organization - Although there are no detailed studies of religion and religious organization in the Upper Valley the available general observations would support the suggestion that formal church organization and beliefs, with folk beliefs, are similar to those on the north slope of Cerro Gordo.

Only the two cabeceras, Otumba and Axapusco, have resident priests. In those communities with chapels or churches a priest celebrates mass about once a month. At other times the inhabitants go to the parish seat for mass.

In San Pablo Isquitlan some individuals belong to religious associations which hold meetings about once a month in Otumba. None of the associations are restricted in members to this community. Both men and women belong although there is a tendency for women to be more active. Membership is based on a personal decision and is considered to be of value in avoiding disasters and in promoting good crops.

No details on religious association membership are available for other communities in the Upper Valley. However, in Maquixco Alto, San Cristobal and San Pablo there is no correlation between location of residential units and membership in an religious association. This is also true for the several lay offices within the church held by local residents.

The selection of Axapusco and Otumba as parish seats accounts for the rather large and ornate churches present in those communities as opposed to the other communities in the Upper Valley. However, there is no relationship between this and the densities of population and residential complexes within the communities. On the basis of the other data available for the Upper Valley and the north slope of Cerro Gordo there does not appear to be any connection between religious organization and intra-community densities of houses and population.

Services - In general there does not seem to be a close correlation between community population and residential unit densities and the number or types of services immediately available to the inhabitants. Although data are not complete the services available to some of the communities in the Upper Valley have been tabulated in Table 21.

Table 21

SERVICES IN UPPER VALLEY COMMUNITIES

COMMUNITY	SCHOOL	BUS	MILL	STORE	ROAD	WATER	ELEC.
POYOXCO	--	--	--	--	--	--	--
Sta. M. TLALMIMILOLPA	X	--	--	--	X	--	--
TOCUILA	--	--	--	--	--	--	--

Table 21-Continued

COMMUNITY	SCHOOL	BUS	MILL	STORE	ROAD	WATER	ELEC.
Sta. M. BUENAVISTA	X	--	--	--	X	--	--
Sn. MARTIN AGUATEPEC	X	X	X	X	X	?	?
AXAPUSCO	X	X	X	X	X	X	X
CUAHUTLAZINGO	X	--	X	X	X	--	X
OXTOTIPAC	X	X	X	X	X	?	?
SAN MARCOS	X	X	X	X	X	?	?
SANTIAGO TOLMAN	X	--	X	X	X	X	X
SANTIAGO TEPETITLAN	X	X	X	X	X	--	--
BELEN	X	X	X	X	X	--	X
OTUMBA	X	X	X	X	X	X	X
SAN PABLO ISQUITLAN	X	X	X	X	X	X	X

In general the compact rancherias have fewer services than do the other types of communities. Although there is some correlation between population density and services available this is not precise enough to suggest a causal relationship between the two features. The presence and absence of services is more a function of distance from main lines of communication rather than a function of population densities. Thus more isolated communities tend to have fewer services than those which are more easily reached. This is also related to the types of materials used in house construction mentioned earlier.

Social Organization - In Table 22 is presented an analysis of the social composition of each residential complex within San Pablo Isquitlan. In addition comparable data from Diehl's research in Santiago Tepetitlan, representing part of that community, have been included.

Table 22

RESIDENTIAL UNIT COMPOSITION-UPPER VALLEY

COMPOSITION	San Pablo Isquitlan		Santiago Tepetitlan*	
	No.	%	No.	%
Nuclear Family (true)	26	36.6	specific data unavailable	
Partial Nuclear Family (one of F., M., Ch., absent)	6	8.4		

Table 22-Continued

COMPOSITION	San Pablo Isquitlan No.	%	Santiago Tepetitlan* No.	%
Nuclear Family and Peripheral Relatives	6	8.4	specific data	
Partial Nuclear Family and Peripheral Relatives	7	9.8	unavailable	
Total	45	63.2	23	68.0
Persons Living Alone	2	2.8	no data available	
Extended Families (two or more true or variant nuclear families)				
Father; Married Son	12	17.0		
Father; Married Daughter	--	--		
Father; Two Married Sons	3	4.2	specific data	
Father; Married Son and Married Daughter	2	2.8	unavailable	
Two Married Brothers	1	1.4		
Two Married Sisters	1	1.4		
Married Brother and Married Sister	3	4.2		
Nuclear Family; Wife's Married Brother	1	1.4		
Total	23	32.4	10	29.0
Others				
Grandmother-Granddaughter	1	1.4	no data available	
Unrelated	--	--	1	3.0
TOTAL	71	99.8	34	100.0

* Data for Santiago Tepetitlan represent a sampling of 34 residential complexes with 215 occupants. The community has a total population (1960) of 536.

San Pablo Isquitlan has a higher proportion of extended families than either Maquixco or Colhuacan. The community has slightly more such families than Santiago Tepetitlan. I have suggested (1965: 132) that variations in the average number of occupants per residential complex can be accounted for on the basis of a greater percentage of extended families within a community. The data from San Pablo Isquitlan, Colhuacan and Maquixco Alto is summarized in Table 23 along with data from Diehl's surveys in the Upper, Middle and Lower Valley. This data is also plotted in Figure 14. The data tend to show that as the percentage of extended families within a community increases the average number of persons per residential complex increases. Thus variations in familial structure

in communities in the Teotihuacan Valley are reflected in variations in the average number of residents per residential complex.

Table 23

SOCIAL STRUCTURE AND RESIDENTIAL COMPLEXES

COMMUNITIES	Extended No.	Extended %	Nuclear No.	Nuclear %	Other No.	Other &	Average per Res. Complex
Cerro Gordo-North Slope							
Sn. Cr. Colhuacan	9	15.6	46	79.7	2	3.5	5.61
Sta. M. Maquixco	8	11.4	49	71.8	11	15.8	4.80 (Core area)
Upper Valley							
Santiago Tepetitlan	10	29.0	23	68.0	1	3.0	6.32
Sn. Pablo Isquitlan	23	32.4	45	63.2	3	4.2	7.00 (1964)
Middle Valley							
Sn. Juan Teotihuacan	110	37.0	228	67.0	--	--	6.05
La Villa	55	30.0	123	67.0	5	3.0	5.88
Purificacion	22	32.0	47	68.0	--	--	6.14
Sn. Juan Evangelista	19	32.0	39	65.0	2	3.0	6.53
Puxtla	14	41.0	19	56.0	1	3.0	5.89
Palapa	11	19.0	46	79.0	1	2.0	5.08
Lower Valley							
Cuanalan	24	35.0	42	62.0	2	2.0	5.81

I have also indicated in an earlier study (1965: 134) that there is a possible correlation between the density of occupied residential complexes within a community and the percentage of nuclear families within the community. This conclusion is based on a comparison of the materials for Colhuacan, Maquixco Alto and San Pablo. Additional data is available from other communities in the Teotihuacan Valley as to occupied residential complex densities within communities so the conclusion must remain tentative.

Using the percentage of nuclear families in communities in the Teotihuacan Valley and plotting those percentages against internal population densities within a community (Figure 15) a slight correlation can be demonstrated between nuclear families and internal population densities. As nuclear families decrease in frequency within the communities the internal population densities tend to increase.

Thus it appears probable that in the communities of the Teotihuacan Valley the social structure of residential complexes and the internal or community pattern are related.

Economic Organization - Although detailed studies have not been carried out in most communities of the upper valley the majority would appear to be rural in nature with most of the population being maintained through agricultural

activities. Data from San Pablo Isquitlan indicate that at least 86% of the residential complexes are supported by activities directed toward the raising of crops. As in Maquixco and Colhuacan, however, there are variations in the nature of the participation of the residential complexes in the basic means of production, land. Other differences are to be found in the types of production activities supporting the residential complexes. Data on land holding and occupations is summarized in Tables 24 and 25 including data from Diehl's survey of three other rural communities. Omitted from consideration are the barrios within San Juan Teotihuacan as most of the inhabitants, according to Diehl, are supported by non-agricultural activities.

Table 24

RESIDENTIAL COMPLEXES AND LAND HOLDINGS-TEOTIHUACAN VALLEY

TYPE	San Pablo		Tepetitlan		Palapa		Cuanalan	
	No.	%	No.	%	No.	%	No.	%
No Lands	30	42.2	4	13.0	17	29.0	19	28.0
Ejido	--	--						
Private	21	29.5						
Pr. and Ejido	3	4.2	No detailed data available					
Pr., Ej., and Hacienda	5	7.0						
Pr., and Hacienda	4	5.6						
Hacienda	8	11.2						
Pr. or Ejido	--	--	27	87.0	42	71.0	48	72.0

Comparing the data in the two tables with those from Maquixco Alto and Colhuacan in Tables 8 and 9 it is evident that as landholding becomes restricted to fewer complexes within a rural community there is a shift away from occupations directly concerned with food production to occupations indirectly concerned, involving wage labor in agricultural activities. In addition there is an increase in the number of complexes supported by non-agricultural activities. Furthermore, differences in the percentages of residential complexes holding lands are correlated with internal population density and with occupied residential complex density within the communities. These tend to vary inversely to the percentage of land holding residential complexes in a rural community.

Table 25

RESIDENTIAL COMPLEXES AND OCCUPATIONS-TEOTIHUACAN VALLEY

	San Pablo		Tepetitlan		Palapa		Cuanalan	
	No.	%	No.	%	No.	%	No.	%
A-DIRECT								
Campesino	9	12.6	23	72.0	53	96.0	66	65.0
Campesino and								
-molinero	1	1.4						
-comerciante	1	1.4						
-jornalero	15	21.1						
-obrero	--	--						
-pastor	--	--						
-albanil	1	1.4						
-adobes	--	--	Detailed data not available					
-tinacal	1	1.4						
-tlachiquero	--	--						
-comerciante and albanil	1	1.4						
-jornalero, obrero and tienda	1	1.4						
-jornalero, tinacal	1	1.4						
Total	32	44.9	23	72.0	53	96.0	66	65.0
B-INDIRECT								
Jornalero	25	35.2						
Jornalero, Obrero	4	5.6	Data not available					
Total	29	40.8						
C-OTHER								
Obrero	9	12.6	8	25.0	1	2.0	24	23.0
Obrero, molinero	1	1.4						
Soldier			1	3.0				
Singer					1	2.0		
Comerciante							12	12.0

Data on land tenure and internal population density is plotted in Figure 16. It should be noted that Palapa does not fit the pattern suggested due to the high percentage of complexes with no lands. My impression is that Diehl's data for this community are not accurate concerning land tenure. He has mentioned that his work generated a great amount of suspicion because a new highway was under construction in the valley and there was fear the government would take lands away from the inhabitants. Furthermore, persons in such

rural communities tend to be very secretive when approached about matters of land tenure. It was difficult to obtain accurate figures on the amount of land held by each residential complex in the three communities I studied. In addition it is possible that the limited sample from Palapa has introduced a bias into the data. I am inclined to believe that this is not the case and that the people of Palapa simply did not admit to owning land when they did. Although the data from Palapa has been included in the tables and graph, it cannot be considered reliable.

Taking into consideration the data from other communities in the valley and on the north slope of Cerro Gordo, it appears that when land tenure becomes restricted to a few residential complexes there are correlated changes in occupations, residential complex densities, population densities and social structure of residential complexes. In the communities examined in detail, as land tenure becomes restricted to fewer complexes, direct agricultural occupations decrease, internal population densities increase, residential complex densities increase, and extended families increase in frequency.

The precise mechanism through which land tenure affects these features of community patterns has not been studied. I am of the opinion as a result of my work in San Pablo, Maquixco Alto and Colhuacan that the availability of ejido land and the nature of the inheritance of private property is significant in relating land tenure to population densities and other aspects of community patterns mentioned before. Economic independence, which results from holding land, is reflected in a dispersal of residential complexes over a wide area. When land tenure is restricted through the non availability of ejido lands and/or an inheritance pattern which keeps the lands of the father undivided and worked by all the sons until the father is very old or dies, then difficulty in establishing a functioning independent economic production and consumption unit is reflected in greater internal population densities and more extended families. Lewis (1964: 491) has noted this in Tepoztlan. "The practice of not dividing up the property until the death of the parents often resulted in married sons with as many as five children being landless and without a house of their own."

Since all the communities studied in detail have adequate land to support themselves the major feature of land tenure which affects community patterns would appear to be not the physical presence of land but rather the social availability of land to the individual for house construction and for agriculture. The social availability of land includes two interrelated factors. If there is land available for new house construction in an area outside the presently occupied zone, then the village will spread out. This will occur, however, only if there is agricultural land available to be utilized directly by the new residential unit.

It becomes more difficult to obtain land either for houselots or for agriculture as one moves from Colhuacan to Maquixco and to San Pablo. Partly as a result of lack of socially defined residential land the internal densities of the communities become greater. In addition, the lack of socially available agricultural land which may be assigned to various residential units has resulted in extended families and patron-client relationships. A father will hold the land until he dies in San Pablo and his sons will live with him and work the land together. In addition those who lack lands develop a patron-client relationship with those with large areas of agricultural land.

These patron-client relationships are reflected in the number of persons who are jornaleros in each community. The number increases from Colhuacan to Maquixco and San Pablo at the same time as population densities increase and landholding units decrease. To operate efficiently a patron-client relationship needs proximity between the principals. Consequently the increased densities may be seen as functional for such a relationship. It should be noted that such a relationship also enables the distribution of land throughout the community despite its unequal official distribution as seen in ownership and ejido holding.

It is interesting to note that Foster has reported a similar relationship between community patterns and land tenure in Spain.

> In a general sense the south is a region of latifundios, great estates of 500 to 1,000 and more hectares, whereas the north, especially Galicia, is a region of minifundios, small plots often so broken up as to be of uneconomic size. Associated with the latifundios of the south are large towns distributed over its region and populated by an agricultural proletariat, workers who go each day, when work is available, to labor for wages on the great estates. Small villages, scattered farms, and widespread individual ownership of small holdings are associated with the north (1960: 51).

Perhaps there is a wider cross-cultural correlation between agricultural workers without lands and dense community patterns.

Summary - Although concerned mainly with the Upper Valley I have tried to develop several hypotheses which will explain variations in community patterns not only within the Upper Valley but throughout the entire Teotihuacan Valley.

Historical factors account for the presence or absence of a grid iron plan in the communities mentioned. The plan was introduced by the Spanish into some but not all communities. It is best considered to be a partially diffused culture trait with a limited distribution in communities in the Teotihuacan Valley. At this time we must leave open the explanation of this differential diffusion.

The presence of specialized structures in communities is related to their political and religious status as well as to their proximity to main lines of communication. This is true of services as well.

The social composition of residential complexes is related to such features of community patterns as the internal population density and the average number of occupants per residential complex. The social composition of the residential complex depends, in rural communities, on other variables the most important of which is land tenure. I have not attempted to use land tenure as a factor to account for the variations in internal population density and other factors in urban and incipient urban communities in the Teotihuacan Valley.

Land tenure, as Chang has suggested (1958), appears to be the key to differences in community patterns. The average number of residents per complex, the density of occupied residential complexes, and the total population density within the community are correlated with land tenure patterns. As land holdings become restricted to fewer complexes in a rural community basic subsistence

occupations change. Within the community there is an increase in occupied residential complex density and in internal population density. These reflect the difficulties in establishing a functioning independent economic production and consumption unit and the increased economic interaction between residential complexes in the form of patron-client relations. A further influence of restricted land tenure may be seen in the increased number of extended families which account for the higher average number of occupants per complex.

The major controlling factor involved in land tenure includes both the availability of land and the inheritance pattern. Given restrictions in either or both, changes in community patterns will result. Detailed studies should be carried out on inheritance patterns and availability of ejido land to determine how they relate to variations in community patterns.

Zonal Patterns

1. Geographic Patterns

In Table 26 the locations and elevations (where available) for the communities of the Upper Valley have been tabulated. Most are located in the piedmont and ridges which surround the small alluvial plain at Otumba and the larger alluvial plain of the Middle Valley. Only three communities are on the plain. The compact rancherias tend to be located on the ridges and hilltops to the east and southeast of the valley floor while the several varieties of villages are on the immediately adjacent hillslope or piedmont. The only urban community, Otumba, is on the valley floor. The other cabecera, Axapusco, is on the piedmont just to the north of Otumba. The populations have been given for the communities in each area to indicate the greater concentration of population in those communities which are on or near the valley floor.

Table 26

UPPER VALLEY - COMMUNITIES

COMMUNITIES	TYPE	LOCATION	POPULATION	DENSITY Per Km^2
Sn. P. Isquitlan	H.D.C.V.	Plain-2320 M.	476	4760
Sta. M. Cholpa	Sc. V.	Plain-2340 M.	227	908
Otumba	Town	Plain-2360-80 M.	1919	2558
Total			2622-20.37%	
Santiago Tolman	C.L.D.V.	N. Pied-2350 M.	1567	1567
Axapusco	Town	N. Pied-2240-60M	1270	508
Tecuautitlan	C.L.D.V.	N. Pied	281	1497
Total			3118-24.22%	

Table 26-Continued

COMMUNITIES	TYPE	LOCATION	POPULATION	DENSITY Per Km^2
Xaltepec	C.L.D.V.	E. Pied.	1406	2038
San Marcos	Sc. V.	E. Pied.	851	851
Sn. Martin Aguatepec	Sc. V.	E. Pied.	569	503
Sta. M. Buenavista	C. Rch.	E. Pied.	369	492
Total			3195-24.82%	
Poyoxco	C. Rcha.	S.E. Ridges	8	12
Sta. M. Tlal-mimilolpa	C. Rcha.	S.E. Ridges 2440 M.	40	106
Tocuila	C. Rcha.	S.E. Ridges 2440 M.	79	158
S. Mig. Xolco	C. Rcha.	S.E. Ridges 2500 M.	124	124
Sn. Fr. Tlaltica	C. Rcha.	S.E. Ridges 2450 M.	544	290
Cuahutlazingo	Sc. V.	S.E. Ridges 2350 M.	931	580
Total			1726-13.41%	
Oxtotipac	Sc. V.	S. Pied. 2400 M.	684	684
Belen	C.L.D.V.	S. Pied. 2400 M.	988	2232
Santiago Tepetitlan	C.L.D.V.	S. Pied. 2400 M.	536	2036
Total			2208-17.15%	

The heaviest population in the Upper Valley is found on the valley floor and on the adjacent north and east piedmont. Of a total population of 12,869, 8,935 or 69.43% reside in those areas. The most lightly occupied areas are the southeastern ridges with 1,726 or 13.41% of the population and the south piedmont with 2,208 or 17.15% of the population. Most of the compact rancherias are in the southeastern ridges. The other community types are scattered throughout the other areas mentioned.

Table 27 presents the distribution of population in the Upper Valley by community type.

Table 27

UPPER VALLEY - COMMUNITY TYPE

COMMUNITY TYPE	Plain	N. Pied	E. Pied	S.E. Ridges	S. Pied	Pop.
Compact Rancherias			1	5		1164-9.04%
Scattered Villages	1		2	1	1	3262-25.34%
Compact Low Density Villages		2	1		2	4778-37.12%
High Density Compact Villages	1					476-3.69%
Incipient Urban Towns		1				1270-9.86%
Urban Towns	1					1919-14.91%
Totals	3	3	4	6	3	12,869

From this listing it is apparent that most of the population in the Upper Valley lives in scattered villages and compact low density villages (62.46%). The remainder live in four different types of communities. If the two cabeceras are grouped they have 24.77% of the population. Only 3.69% live in a high density compact village and the remaining 9.04% live in compact rancherias.

Most of the communities in the Upper Valley are located near hillslope areas from which they can obtain a water supply. Even those communities on the plain have land on hillslopes where they have jagueyes. Today this has become less essential with the gradual provision of piped water to many of the communities such as Otumba and San Pablo. The general arrangement of communities on slopes in the Upper Valley was apparently devised to ensure a water supply from runoff.

2. Cultural Patterns

The communities within the Upper Teotihuacan Valley are culturally interrelated in a variety of ways. Politically they are included in three municipios, Axapusco, Otumba and San Martin. Two of the cabeceras are located in the Upper Valley, the other, San Martin is in the Middle Valley.

The two cabeceras also are parish seats for the communities of the Upper Valley. Detailed information is unavailable on the exact relation between the cabeceras and the communities and there is some evidence which suggests that municipal and parish boundaries are not the same. The presence of religious associations in Otumba also serves to relate the communities in this area. San Pablo Isquitlan and Cuahutlazingo are tied with San Martin and the Hacienda Cerro Gordo through the fiesta of Nuestro Senor de la Cana which has been described in the paper on contemporary agriculture.

In the Upper Valley, as in the Cerro Gordo-North Slope area, the most significant relations between communities are economic. These ties link the communities within the area as well as relating them to centers outside the Upper Valley. It is probable that many of these connections outside the area are the result of recent improvements in the highway system.

Mexico City, Ciudad Sahagun and Texcoco are important centers outside the Upper Valley where the inhabitants purchase goods and participate in the industrial labor market. In addition some campesinos from Santiago Tolman have ejido lands on the east coast in Vera Cruz where they grow cash crops. Closer to the Upper Valley, San Juan Teotihuacan serves as a market center on Mondays and many of the communities, particularly those on the south piedmont, make purchases there.

Within the Upper Valley Otumba has the only market, which meets once a week on Tuesdays. It tends to be the focal point for many of the communities of the area, particularly those on the plain, the north piedmont, the east piedmont and the southeastern ridges. In addition many people sell wares at the market in Otumba. The permanent stores in Otumba also serve as an attraction for the surrounding communities.

Detailed information from San Pablo Isquitlan indicates that people in this community participate in a variety of economic ties with communities within and outside the Upper Valley. Clients come from San Juan Teotihuacan to San Pablo to buy zacate for their stables. Farmers from San Pablo sell their maize and wheat both in Otumba and in San Juan. Milk is sold daily in San Martin. The fruit grown in San Pablo is sold in the markets at Otumba or San Juan. Occasionally entrepreneurs come from Mexico City or Ciudad Sahagun to purchase an entire crop to sell in those centers. One resident of San Pablo purchases gravel from Chiconcuac and Cuanalan and resells it for construction in Otumba. Wool is sold to entrepreneurs from Chiconcuac. The bricks used in house construction are purchased from Axapusco. Most persons do their regular marketing in Otumba on Tuesdays although purchases are made in Mexico City and San Juan as well. Pulque produced by the tinacal in San Pablo is transported to the railroad station at Otumba to be carried to Mexico City.

The stores in San Pablo are visited at least once a week by a variety of salesmen with soft drinks, beer, candies, cigarettes, and varieties of vegetables. The stores do not carry large stocks but have pots, sandals, and some fruit, as well as the goods mentioned above.

Many of the communities are linked with others through the school teachers who very frequently live outisde the community in which they teach. Buenavista and Santiago Tepetitlan have soldiers teaching in their schools. The teachers in San Pablo live in Otumba and San Martin. Those in Oxtotipac and San Francisco Tlaltica reside in Otumba.

As in the area of the north slope of Cerro Gordo the members of a community are linked with other towns also through kinship and compadrazgo relationships. With respect to origins of populations detailed data is available only for San Pablo Isquitlan and Santiago Tepetitlan.

Table 28

POPULATION ORIGINS-UPPER VALLEY

COMMUNITIES	Native Born (Over 15 Years of Age) No.	%	Non-Native Born (Over 15 Years of Age) No.	%
San Pablo Isquitlan	207	84.14	39	15.86
Santiago Tepetitlan	107	97.28	3	2.72

Most of the individuals born in other communities but living in San Pablo have come to that community through marriage to a resident.

Summary - The communities of the Upper Valley participate in a number of different types of relationships with communities both close and distant. Although there are no detailed studies available on these interrelations the available data definitely indicate their existence.

COMMENTS

William T. Sanders

One of the most interesting and puzzling problems in the contemporary settlement patterns of the valley is the variation in population density of the residential areas of communities in the valley. When I did the field work (as part of my Ph.D. dissertation), mentioned by Charlton, in 1954, I noted the striking range in density on the aerial photographs from 200 per square kilometer up to 6,000. Charlton has located some communities in the Upper Valley with densities of even less than 100 persons per square kilometer. If the chimampa communities in the southern portion of the Basin of Mexico were included in the sample the upper end of the range would rise to 12,000 per square kilometer.

It is obvious from the studies presented by Diehl and Charlton that urbanization is one process leading to denser, more nucleated settlements. Political status also positively relates to urban development although there is a wide range in its effects. It has had remarkable effects on the urban growth of San Martin de las Piramides (a good test case since it was a subject settlement of San Juan until some time between 1930 - 1940). On the other hand the cabecera status of Axapusco has had little effect on urban growth, probably as a result of its close proximity to Otumba. At least one subject community, Tepexpan, has become rapidly urbanized due to its close distance (within that of a bicycle commuter) to the factories of Mexico City. This community will probably be a separate municipal cabecera as the product of urban growth rather than vice versa.

The major puzzle is the variation in density among rural communities. When I did my 1954 survey I noted the very striking tendency for the high density settlements to be located in the Lower Valley and Delta, particularly among those settlements utilizing the irrigation system and located within or on the edge of the alluvial plain. The lower density settlements were generally found in eroded piedmonts up valley; the lowest density settlements, or rancherias, seem to be in the most severely eroded of all areas. This generalization is supported by the unique case of San Pablo Isquitlan in the Middle Valley of a settlement located within the alluvial plain. As Charlton has shown, the correlation is not exact in detail but it certainly is defensible in a broad sense.

I classified the various rural communities in the valley into types based on settlement density as Diehl and Charlton have pointed out. I also noted an interesting historical process in the Lower Valley related to population density. Gamio presents maps of Xometla and Calvario Acolman and the areas of these communities at the period of his study (1910-1920) was almost exactly that on the aerial photographs dating around 1950. The population of Xometla and Calvario Acolman in 1910 was 423 and 342 respectively; in 1940 (the census used in my study) they had increased to 668 and 660. In other words when population increased in these settlements it resulted in a rise of density rather than of surface area. I also noted that in some communities this process apparently reached some kind of a saturation point and the result was the establishment of new, peripheral colonias. This has happened particularly at Cuanalan and Atlatongo. I then concluded that the process related to a

need to conserve agricultural land, particularly the most productive land of the alluvial plain in the Lower Valley and that the response to population growth in such areas was in the form of increased fragmentation of houselots. The high population density of settlements in the alluvial plains area was interpreted as the result of this process. This conclusion is further supported by the fact that those villages within the plain have the highest densities of all. In the piedmont the reverse process was suggested, i.e., as population increases the community spreads out thus maintaining communities with low densities.

The correlation of population density of settlements with degree of productivity of the immediate setting is a close one; and I believe related in part to the process noted. I then went further and suggested that there was a functional relationship between internal population density of community and the productivity of the total land holdings of the village but was unable to explain this in functional terms.

In discussion with Charlton over these points prior to his field studies he questioned both arguments. With respect to my first point he argued that if the population were to be distributed on the individual holdings of agricultural land then the amount of land use for residence would still be the same as in cases where everyone lived in a densely nucleated settlement. I agree, but one must see the process in a historical perspective. Much of the Aztec rural population did live dispersed through terrace systems on the piedmont in 1519. The Spaniards collected these settlements into nucleated settlements with a basic radial plan so one must start with these nucleated settlements as being in existence. The question is essentially what happens to a nucleated, radially planned settlement faced with the dual problems of an increasing shortage of good agricultural land and rising population. If the settlement itself is located within or adjacent to the productive agricultural land the response is to fragment the houselots into smaller ones. But if the settlement is located on marginal hillsides it spreads out in the form of increased surface area and a relatively low density is therefore maintained.

His offered contrast between Cuahutlacingo, Tolman and Isquitlan I believe confuses my two separate conclusions. Tolman and Cuahutlacingo own land in the alluvial plain but both villages are located on marginal hillsides, Isquitlan not only owns alluvial plain but is located within it.

It is with my second point that I believe his discussion most closely relates, that is the suggested relationships between community density and total productivity of village holdings.

In his field study of San Maria Maquixco el Alto, San Cristobal Culhuacan and San Pablo Isquitlan, Charlton has explored in depth the factors that account for variation in settlement density. His arguments involve a chain of cause and effect relationships. The immediate cause of high density is the much higher incidence of extended family residences or multi-family households in the higher density communities. This in turn is the product of variations in landholdings. In some villages a relatively high percentage of the population does not have direct access to land and consists of landless kin in a client relationship to patrons with access to land. The broad correlations between area productivity and settlement type that I noted, but was

never able to explain in functional terms, can now be explained using Charlton's model. The more productive areas have denser populations, greater land shortages and as a consequence larger numbers of people without land. Such lands are also more valuable properties, are less freely distributed and stimulate the desire to accumulate holdings.

Finally, the data collected by both Diehl and Charlton show that since 1940 land shortages have increased in an overall sense and have affected even those communities that are located in marginal lands. Most if not all communities therefore have undergone a substantial rise in population density between 1940-1960. This has occurred to such a degree that communities have moved up a complete gradient in terms of classification. For example, Santiago Tolman was classified by me as a scattered village; it is now a low density compact village.

The reader may note some discrepancies in the density calculations between the paper by Diehl and the paper by Charlton. This reflects differences in methodology in defining the residential area of the village. In Diehl's study and in my earlier study we simply calculated the approximate area from aerial photographs. Charlton, however, uses a system of definition based on local concepts of types of land. The villagers refer to the plots of unused or agricultural land located adjacent to their houses as huertas. They also, however, classify some land on the immediate edge of settlements as huertas (usually with the qualification "huertas del campo") and consider them part of the community as opposed to "campos" which are agricultural fields proper. The villager has a concept therefore of what constitutes the village area versus the agricultural hinterland. In Charlton's three village study he has used the native system and his areal measurements therefore exceed both Diehl's and mine for the same village.

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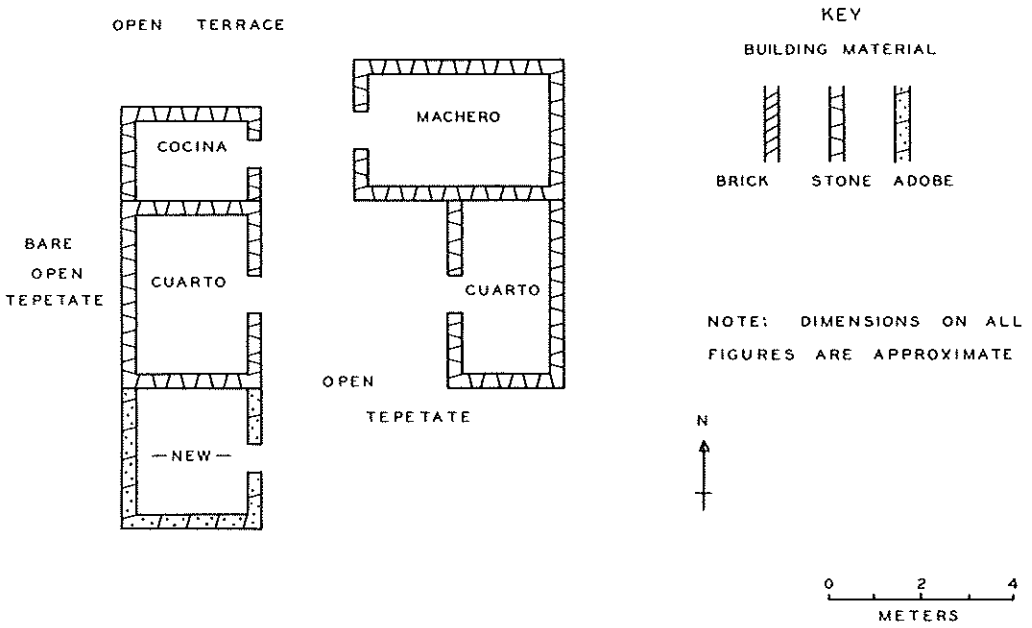

FIG. 1 OPEN HOUSE LOT — COLHUACAN

RR

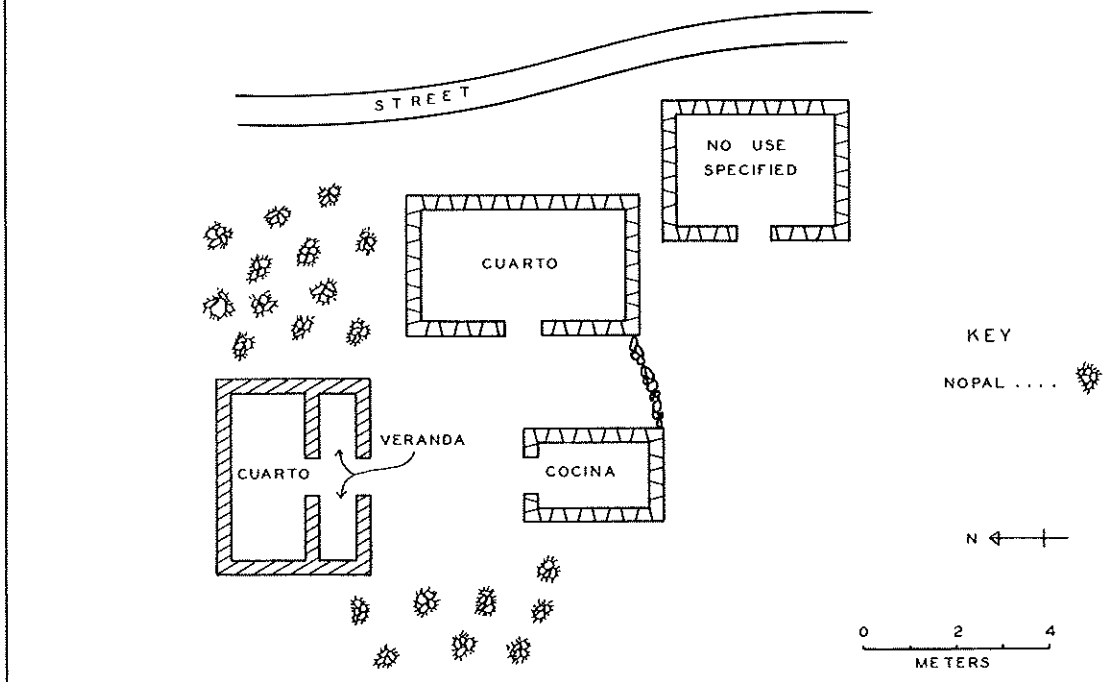

FIG. 2 OBSCURED HOUSE LOT — COLHUACAN

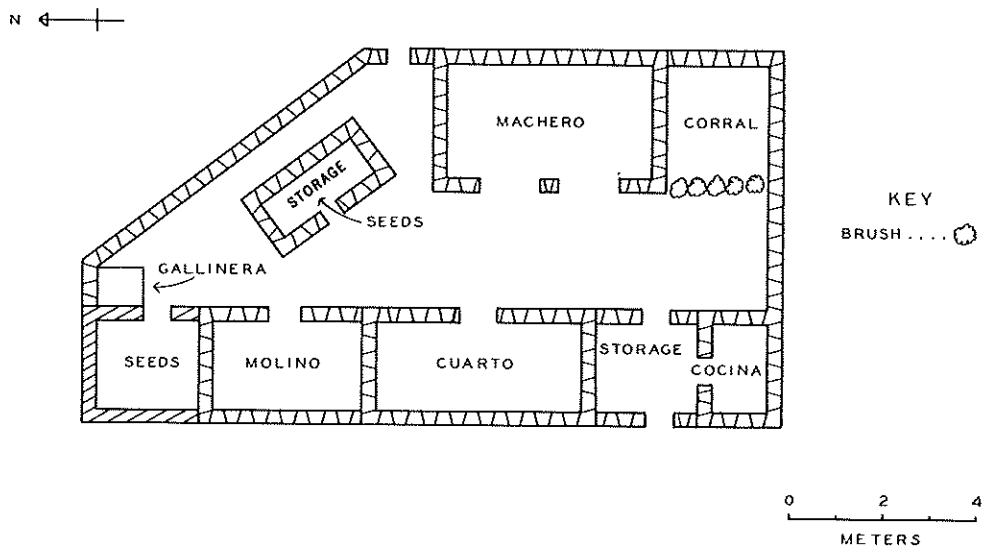

FIG. 3 WALLED HOUSE LOT — COLHUACAN

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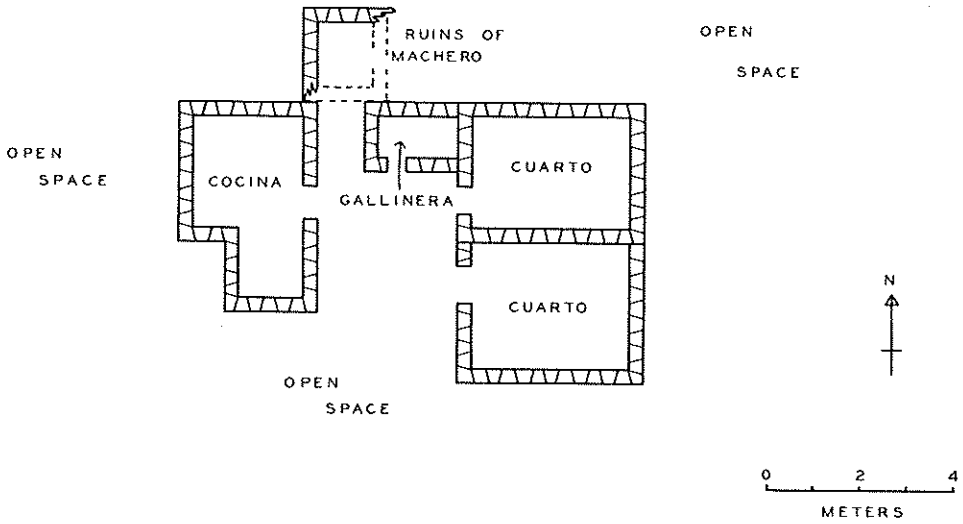


FIG. 4 OPEN HOUSE LOT — MAQUIXCO ALTO

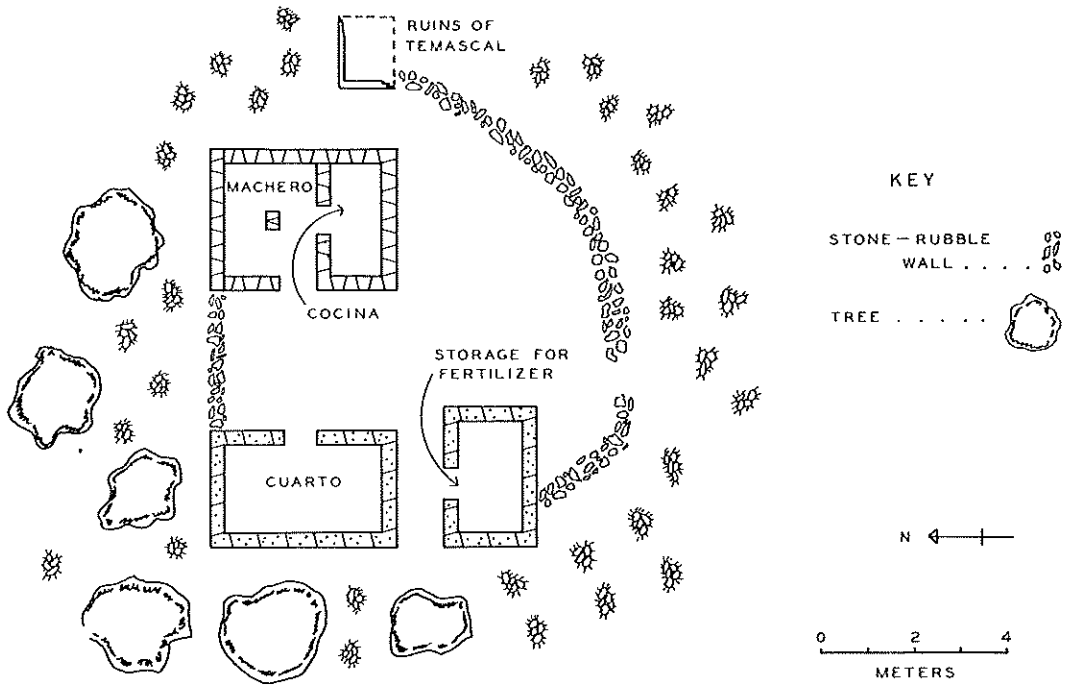


FIG. 5 OBSCURED HOUSE LOT — MAQUIXCO ALTO

RR

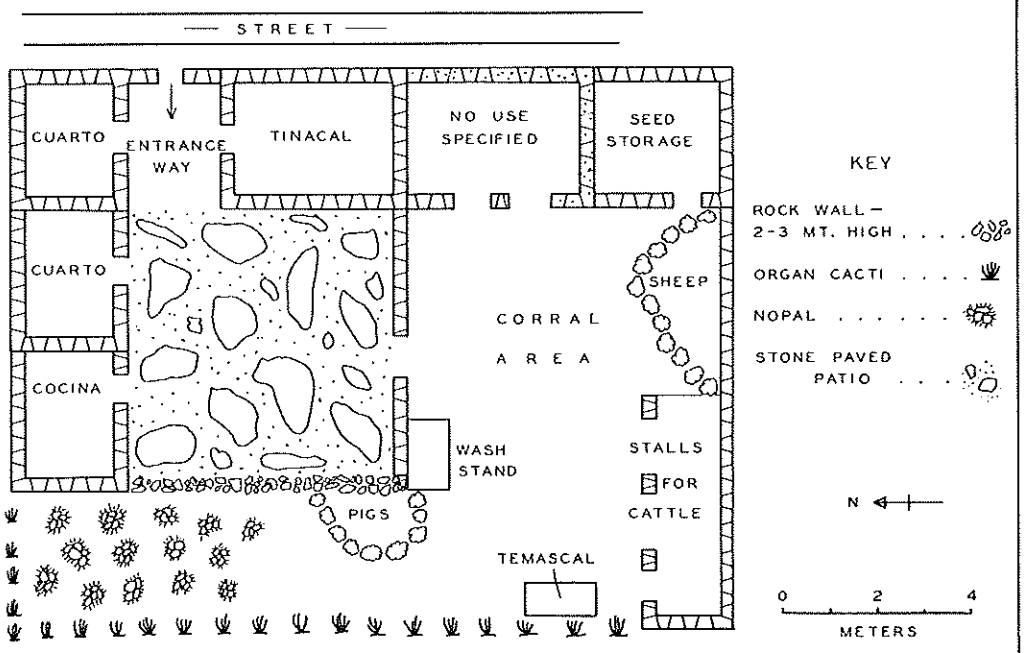


FIG. 6 WALLED HOUSE LOT — MAQUIXCO ALTO

RR

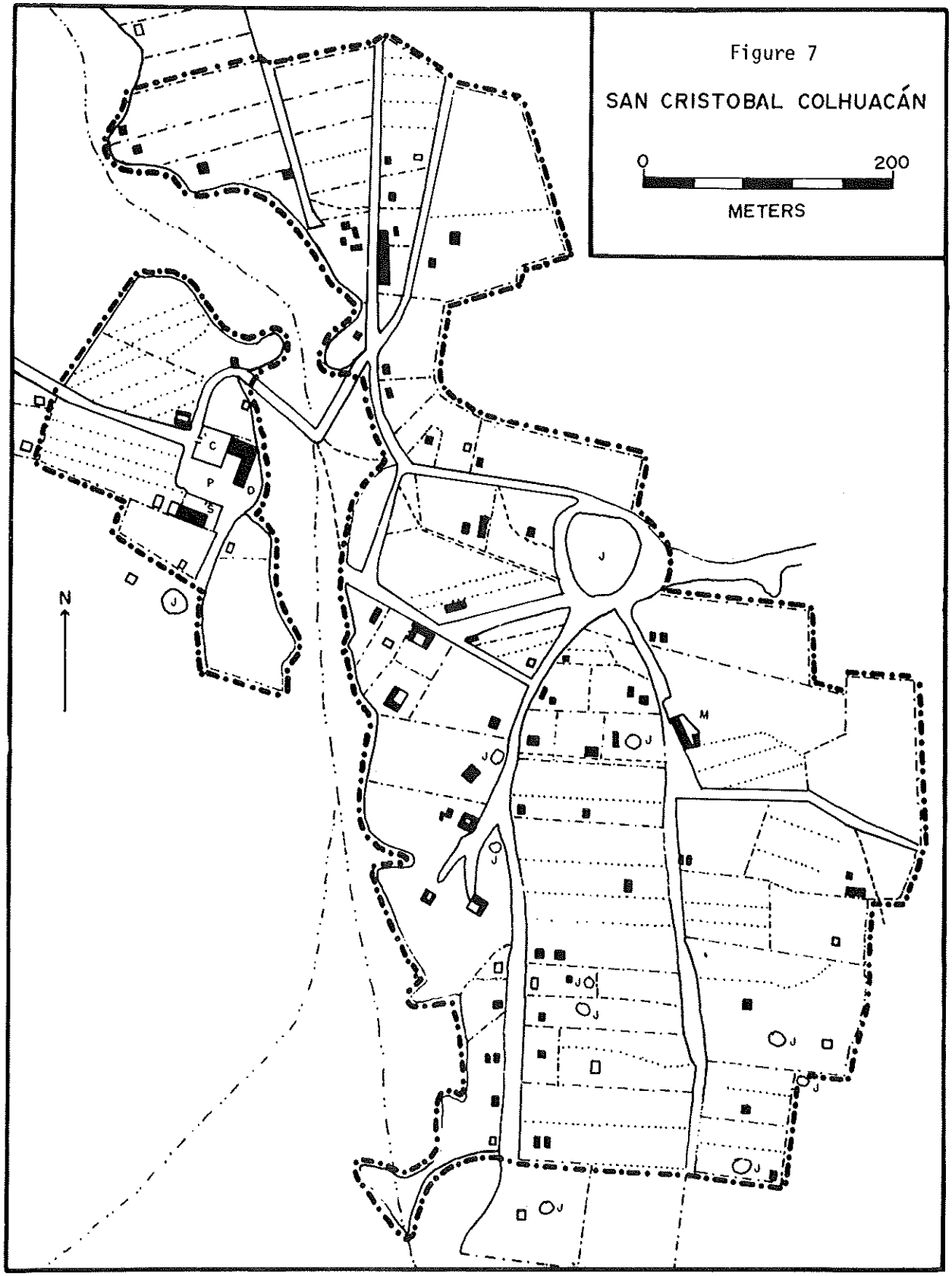


Figure 7
SAN CRISTOBAL COLHUACÁN
0
200
METERS
N
C
P
S
J
M

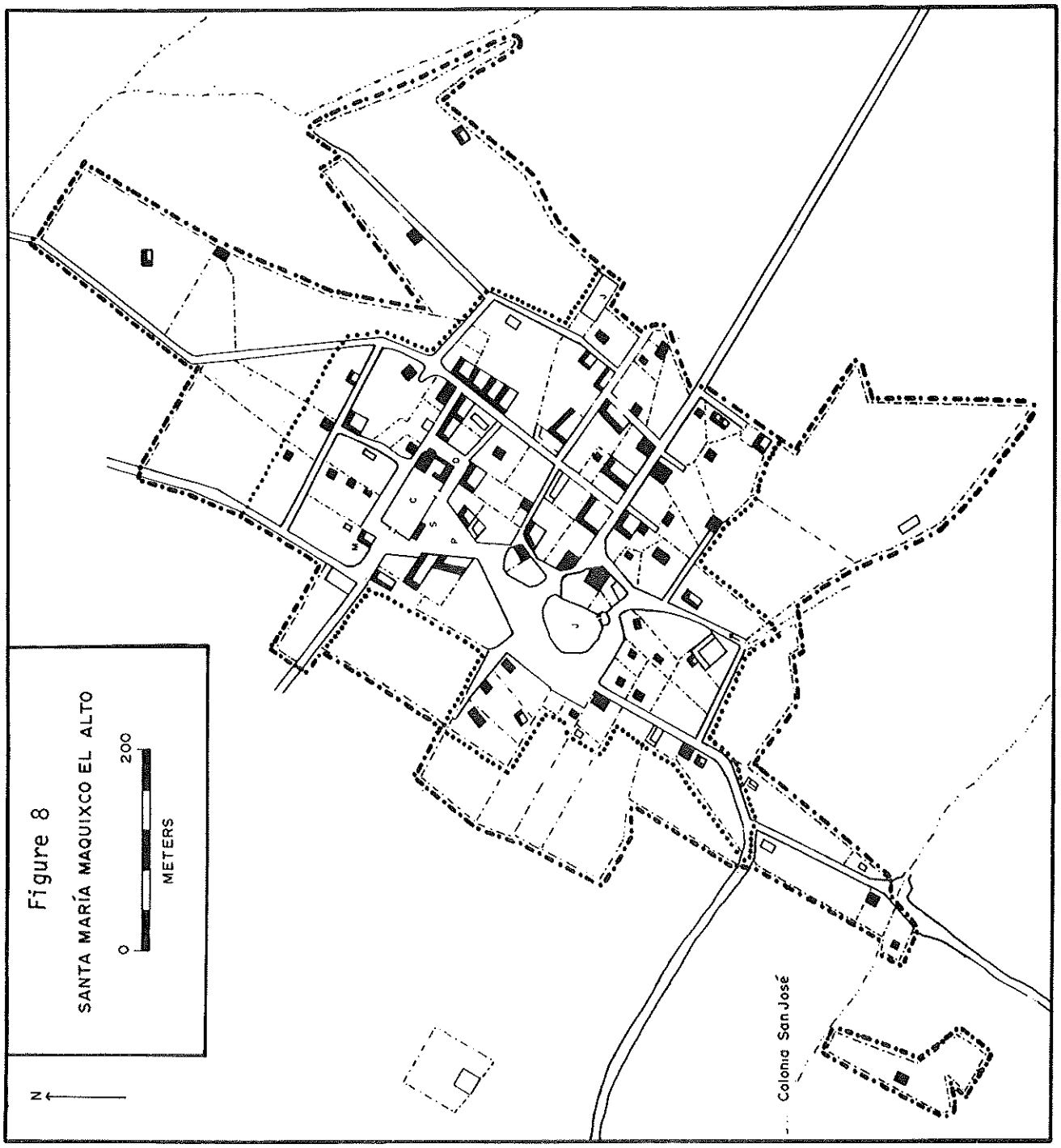


Figure 8
SANTA MARÍA MAQUIXCO EL ALTO
0
200
METERS
N
Colonia San José

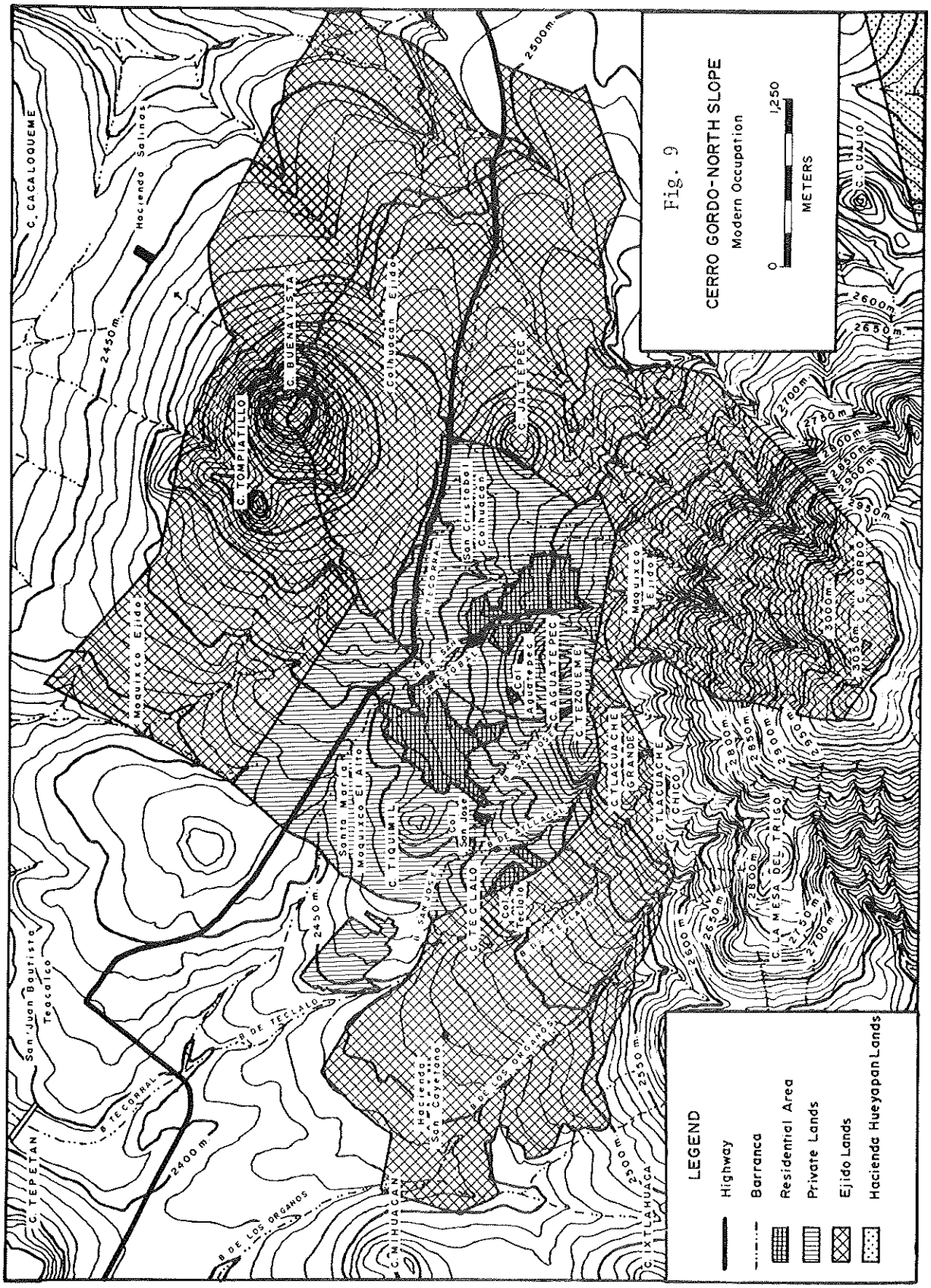

LEGEND
Highway
Barranca
Residential Area
Private Lands
Ejido Lands
Hacienda Hueyapan Lands
CERRO GORDO-NORTH SLOPE
Modern Occupation
0
1,250
METERS
C. CACALOQUEME
C. TEPETAN
C. TOMPIATILLO
C. BUENAVISTA
C. TIQUIMIL
C. TECLALO
C. TLACUACHE
C. TEZQUEME
C. GUAJILPEC
C. CUAJIO
Hacienda Salinas
Hacienda Coyotepec
Maquixco Ejido
Colhuacan
Teacalco
B. DE TECORRAL
B. DE TECLALO
B. DE LOS ORGANOS
LA MESA DEL TRIGO
2400 m.
2450 m.
2500 m.
2550 m.
2600 m.
2650 m.
2700 m.
2750 m.
2800 m.
2850 m.
2900 m.
2950 m.
3000 m.
3050 m.

Fig. 9

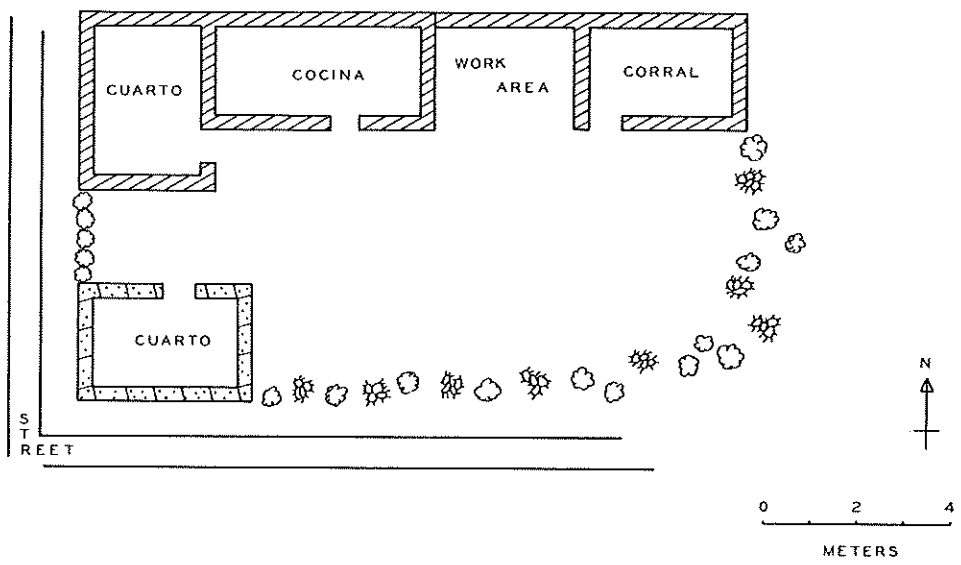


FIG. 10 OBSCURED HOUSE LOT — SAN PABLO ISQUITLAN

RR

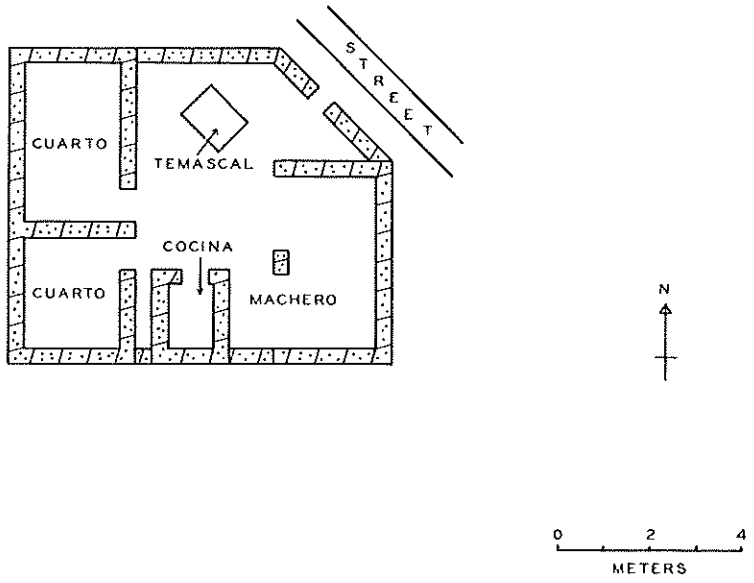


FIG. 11 WALLED HOUSE LOT — SAN PABLO ISQUITLAN

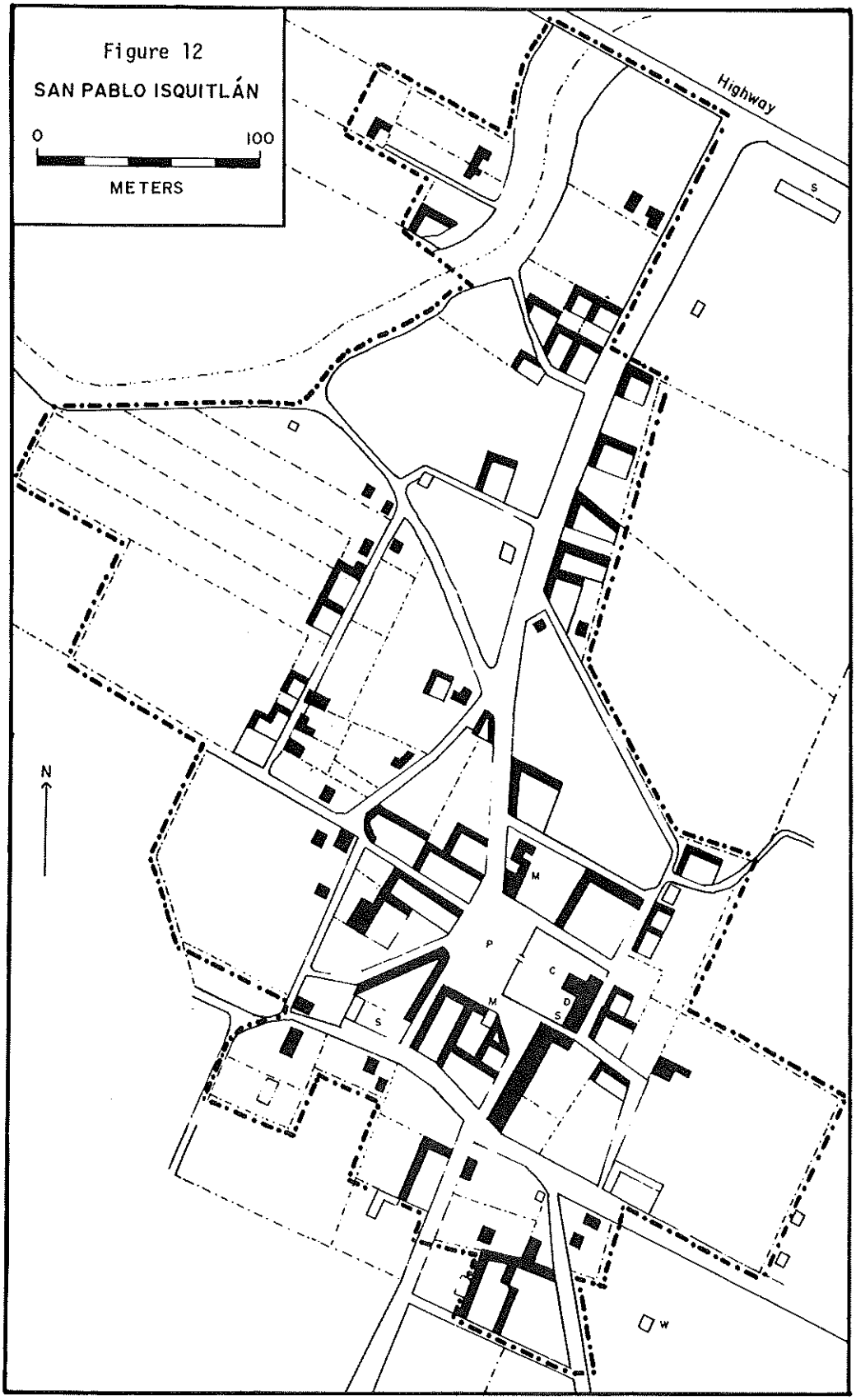


Figure 12
SAN PABLO ISQUITLÁN
0
100
METERS
Highway
N
S
M
P
C
D
S
M
S
W

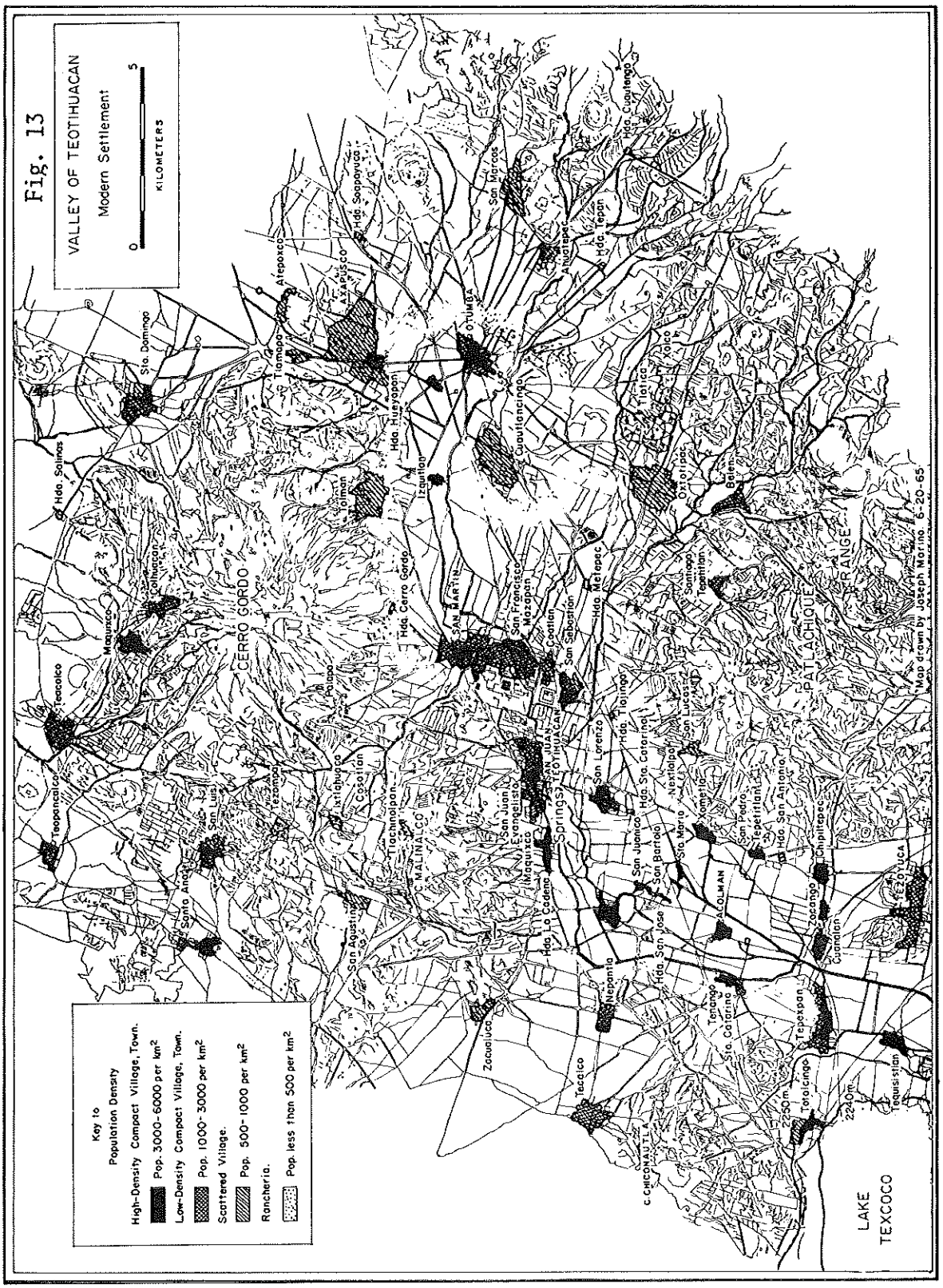


Fig. 13
VALLEY OF TEOTIHUACAN
Modern Settlement
0
5
KILOMETERS
Key to
Population Density
High-Density Compact Village, Town.
Pop. 3000-6000 per km²
Low-Density Compact Village, Town.
Pop. 1000-3000 per km²
Scattered Village.
Pop. 500-1000 per km²
Rancheria.
Pop. less than 500 per km²
CERRO GORDO
SAN MARTIN
PATLACHIQUE RANGE
LAKE TEXCOCO
Map drawn by Joseph Marino 6-20-65

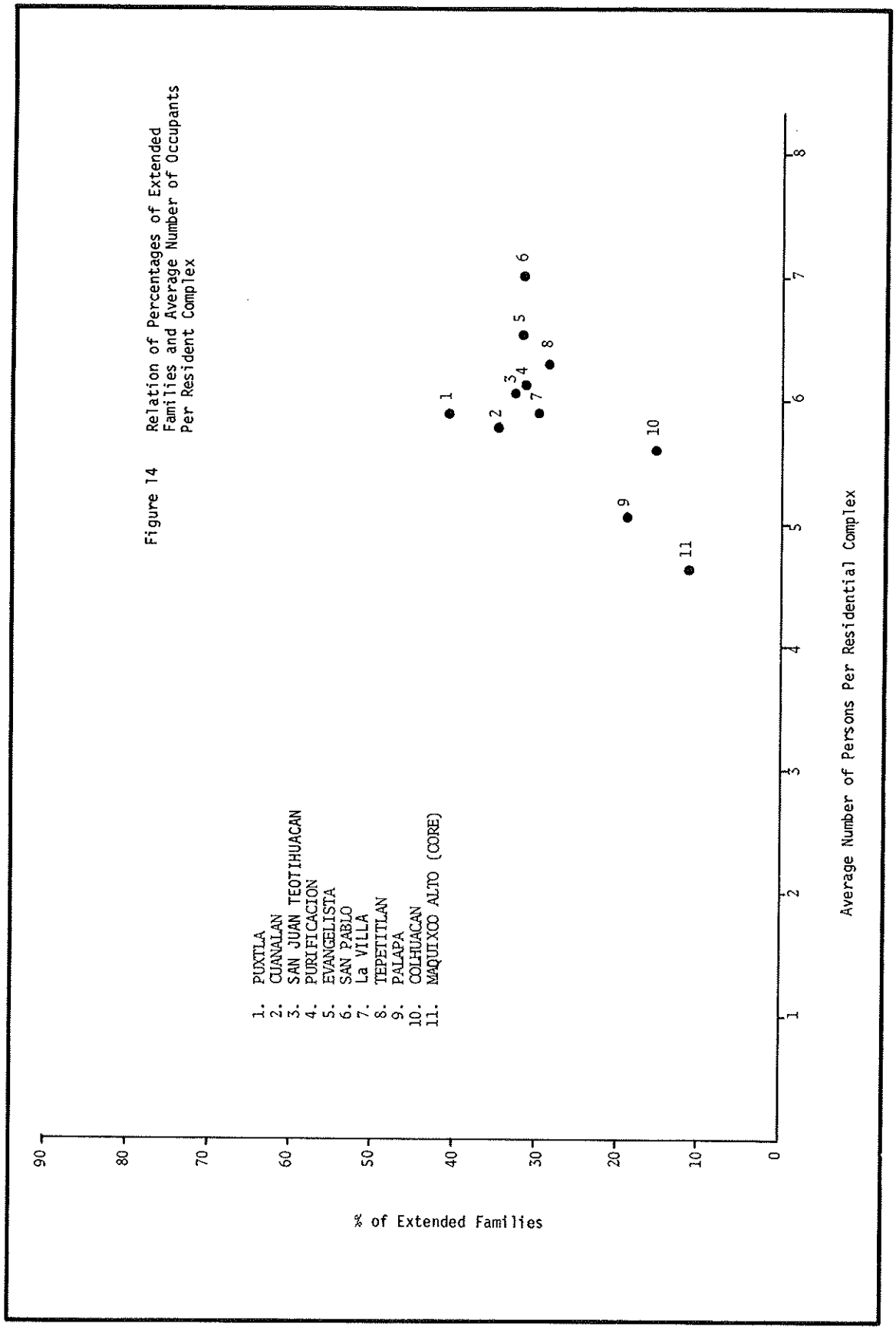

Relation of Percentages of Extended Families and Average Number of Occupants Per Resident Complex
1. PUXTLA
2. CUANALAN
3. SAN JUAN TEOTIHUACAN
4. PURIFICACION
5. EVANGELISTA
6. SAN PABLO
7. La VILLA
8. TEPETITLAN
9. PALAPA
10. COLHUACAN
11. MAQUIXCO ALTO (CORE)
% of Extended Families
Average Number of Persons Per Residential Complex

Figure 14

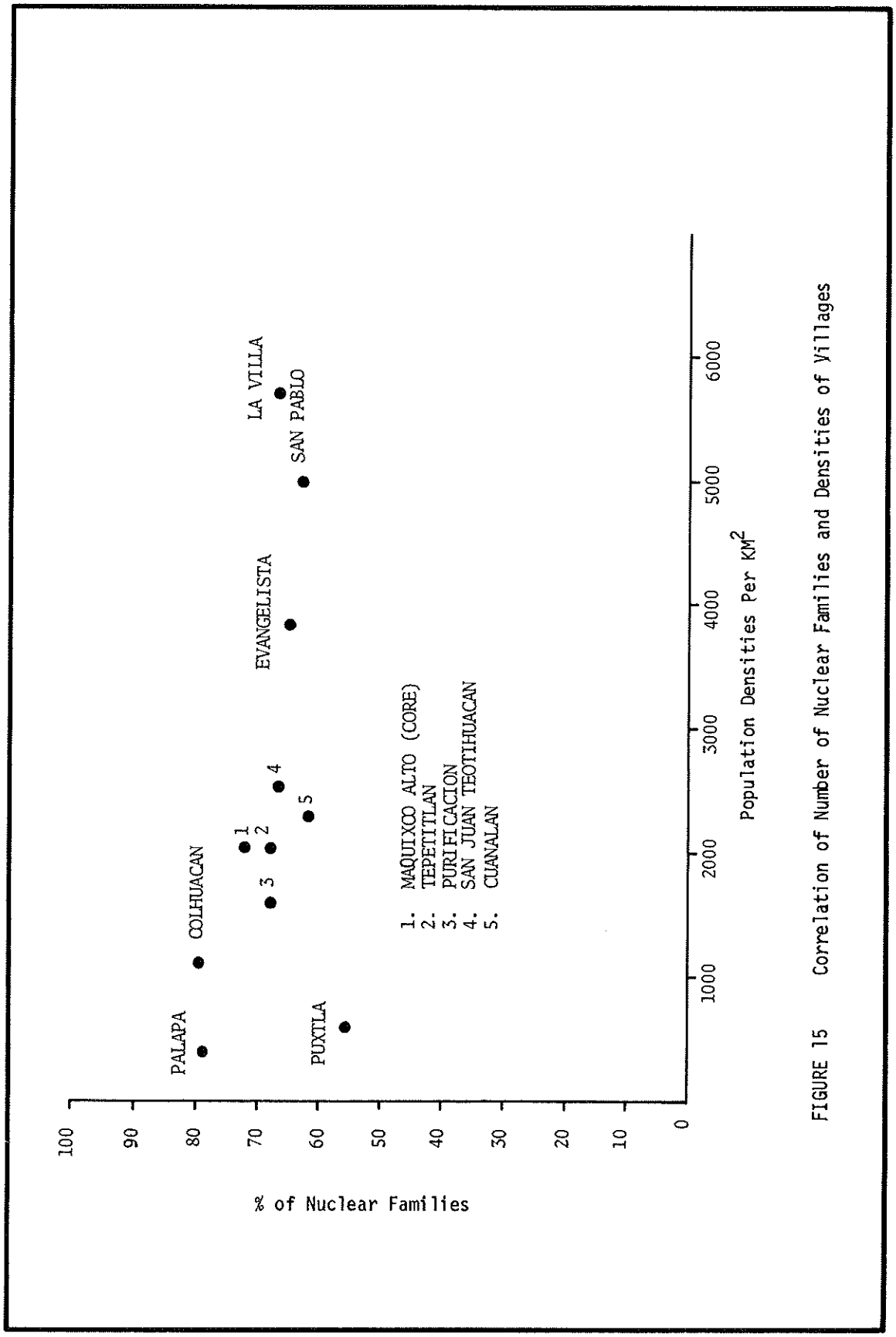
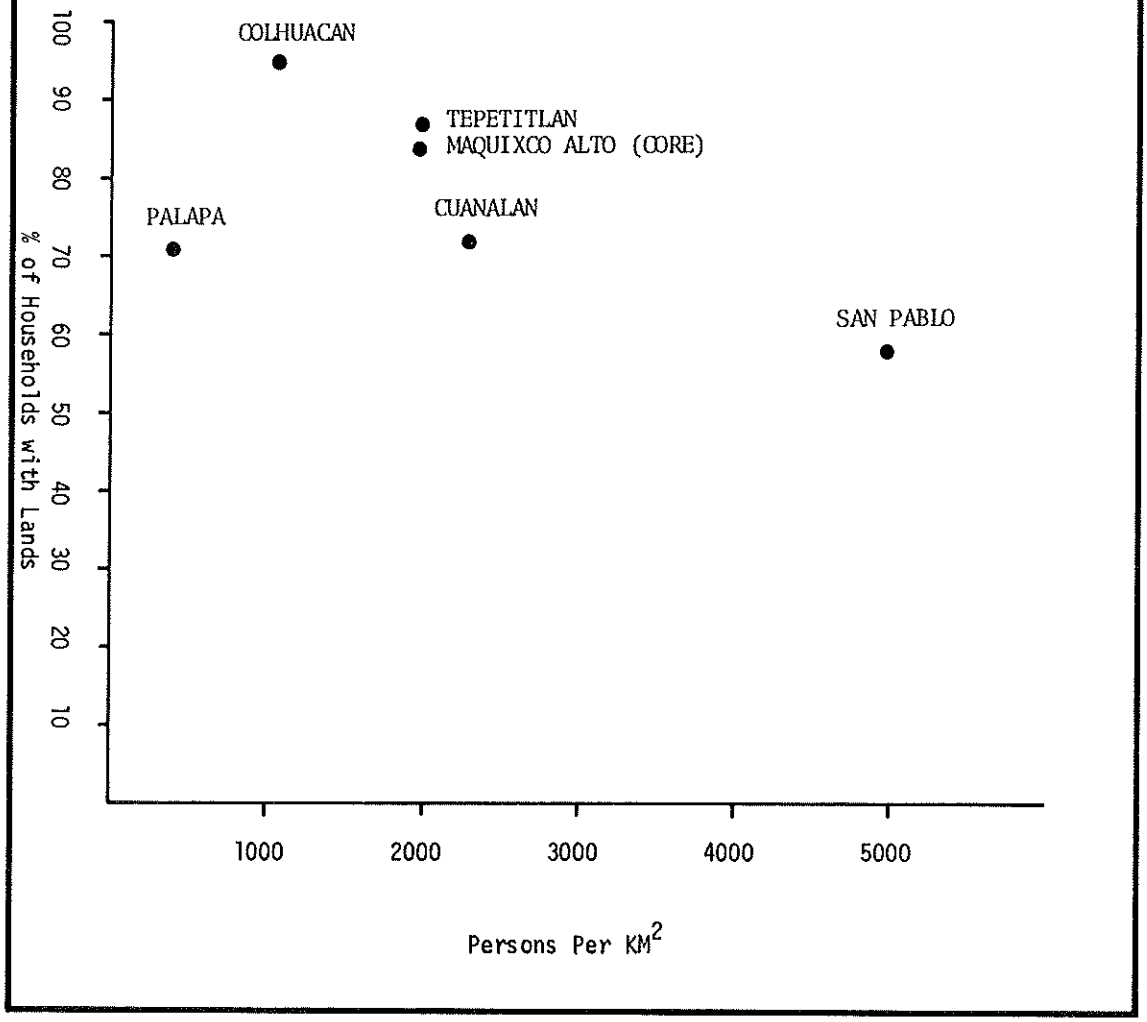


FIGURE 15 Correlation of Number of Nuclear Families and Densities of Villages

FIGURE 16

CORRELATION OF POPULATION DENSITY AND LAND TENURE



CONTEMPORARY AGRICULTURE
in the
TEOTIHUACAN VALLEY

by

Thomas Charlton

Table of Contents

Geographic Background. 258

Land Classification. 260

Soil and Water Management Techniques 263
1. Permanent irrigation. 263
Organization of the System. 264
Conflict and Cohesion in the System 268
Agricultural Significance of the System 269
Other Permanent Irrigation Systems. 270
2. Chinampa Cultivation. 270
3. Flood Water Irrigation. 271
Organization of the System. 273
Conflict and Cohesion in the System 276
Agricultural Significance of the System 277
4. Terraces. 278
Organization of the System. 282
Agricultural Significance of Terraces 282
Bancal Terracing. 283
5. Presas. 284
Organization of Presa Construction. 285
Agricultural Significance of Presas 285
6. Summary 286

Crops. 287
1. Maize 287
2. Wheat and Barley. 288
3. Minor Field Crops 290
Beans 290
Haba Beans. 291
Squash. 291
Peas. 292
Lentils 292
Alfalfa 292
Vegetables. 293
Potatoes. 294
4. Fruit Trees 294
5. Maguey. 295
6. Nopal 298
7. Summary 298

Techniques of Cultivation. 299
1. Tools 299
2. Land Preparation. 300
Barbecho. 300
Rastreo 301
Cruzada 301
3. Sowing. 302
4. Cultivation 304
5. Harvesting. 305
6. Miscellaneous Techniques. 306
7. Organization of Labor for Cultivation 307
8. Summary 308

Land Tenure and Use 309
1. Pequena Propriedad 309
2. Ejido Lands. 309
3. A Medias or En Aparceria 310
4. Renting (En Arrendamiento) 310
5. Summary. 310

Domestic Animals. 312
1. Fowl 312
2. Quadrupeds 312
3. Bees 314
4. Jagueys. 314
5. Summary. 314

The Operation of Agricultural Systems 315
1. Lower Valley - The Permanent Irrigation System 315
Household Economy - Santiago Atlatongo 315
Village Economy - Santiago Atlatongo 316
Household Economy - Calvario Acolman 318
Village Economy - Calvario Acolman 319
Agricultural Economy - Lower Valley. 320

2. Middle Valley. 321
Household Economy - San Pablo Isquitlan. 321
Household Economy - San Martin de las Piramides. 322
Household Economy - Santa Maria Coatlan. 322
Household Economy - San Francisco Mazapan. 322
Hacienda Economy - San Pablo Isquitlan 323
Village Economy - San Pablo Isquitlan. 323
Village Economy - San Martin de los Piramides. 328
Village Economy - San Francisco Mazapan. 330
Village Economy - Santa Maria Coatlan. 330
Agricultural Economy - Middle Valley 330

3. Cerro Gordo - North Slope. 334
Household Economy - San Cristobal Colhuacan. 334
Household Economy - Santa Maria Maquixco el Alto 336
Village Economy - San Cristobal Colhuacan. 337
Village Economy - Santa Maria Maquixco el Alto 340
Agricultural Economy - Cerro Gordo - North Shore 343

Conclusion. 345

Bibliography. 346

ILLUSTRATIONS

Map 1 Lower Valley: The Permanent Irrigation System. 349
Map 2 Middle Valley - Flood Water Dam System. 350
Map 3 San Pablo Isquitlan, Crop Ecology - Main Crops and Land Tenure. 351
Map 4 San Pablo Isquitlan, Crop Ecology - Minor Crops 352
Map 5 San Pablo Isquitlan, Hillslope and Hacienda Hueyapan, Crop Ecology and Land Tenure. 353
Map 6 San Pablo Isquitlan, Crop Ecology - Village Area. 354
Map 7 San Pablo Isquitlan, Land Holdings, Flood Water Canals. 355
Map 8 Cerro Gordo, North Slope - Terrace Systems and Private Lands. . 356
Map 9 Cerro Gordo, North Slope - Land Holding 357
Map 10-11 Cerro Gordo, North Slope - Crop Ecology 358-359
Map 12 Crop Ecology, San Cristobal Colhuacan - Village Area. 360
Map 13 Crop Ecology, Santa Maria Maquixco El Alto - Village Area . . . 361

PLATES

Plate 1 - a. San Jose Canal Near Atlatongo. 363
b. Permanent Irrigation - Water Gate, Secondary Canal . . . .
c. Permanent Irrigation - Showing Cajas or Diked Fields . . .
d. Permanent Irrigation - Cleaning Brush from Canal . . . . .

Plate 2 - a. Rio de San Juan - Water Gate 365
b. Permanent Irrigation - Cleaning Silt from Canal. . . . . .
c. Flood Water Irrigation - Aerophoto of Middle Valley Plain.
d. Middle Valley Plain looking North towards Cerro Gordo. . .

Plate 3 - a. Barranca de Atlamajac - Showing Dry Bed near San Martin. . 367
b. Flood Water Irrigation - Dam without Water . . . . . .
c. San Pablo Isquitlan - Plaza during a Flood in May, 1954. .
d. Barranca de Atlamajac after Heavy Rain . . . . . .

Plate 4 - a. Flood Water Irrigation - Dam with Water. 369
b. Flood Water Irrigation - Field near San Pablo Note use of Caja or Diked Basin. . . . . .
c. Flood Water Irrigation - Milpa in August, 1963 . . . . . .
d. Flood Water Dam in Barranca de Atlamajac . . . . . .

Plate 5 - a. Panoramic View of Eroded Slopes and Terraces near Maquixco Alto. 371
b. Aerophoto - Terraces near Santiago Tepetitlan. . . . . .
c. Aerophoto - Superimposed Terrace System of Different Ages South of Ciudadela on South Piedmont. . . . . .

Plate 6 - a. New Bordo, Near Maquixco Alto 373
b. Well Developed Terrace on Eroded Tepetate Slope. . . . . .
c. Same Terrace from Above. . . . . .

Plate 7 - a. Young Terrace (Maquixco Alto). 375
b. View of Slope near Maquixco Alto, to Right of Canal is a Well Developed Terrace System Planted in Maize, to Left an Unterraced Barley Field . . . . . .

Plate 8 - a. New Bordos (Maquixco Alto). 377
b. Flood Water Canal Serving Terrace System (Maquixco Alto).
c. Old Terraces Disintegrating Through Lack of Maintenance .
d. Field with Main Canal and Intake Canal. . . . . .

Plate 9 - a. Deep Canyon Barranca, Maquixco Alto 379
b. Old Terrace, Well Maintained System in Maize, Maquixco Alto. . . . . .
c. Same System, Closer View. . . . . .
d. Mature, Well Maintained Terrace . . . . . .

Plate 10 - a. Presa (Check Dam) Near Maquixco Alto. 381
b. Presa (Check Dam) Near Maquixco Alto. . . . . .
c. Small Presa with Flood Water Inlet Canal. . . . . .

Plate 11 - a. Jaguey, Near Tolman 383
b. "Castrated" Maguey Plant. . . . . .
c. Nopal Orchard . . . . . .
d. Young Nopal Orchard Showing Planting Technique. . . . . .

GEOGRAPHIC BACKGROUND [1]

Contemporary agriculture in the Teotihuacan Valley represents a synthesis of aboriginal and Hispanic tools, techniques, crops and animals. The variable distribution of particular features of the modern agricultural system within the valley is correlated with differences in the conditions of soil, water and topography. These, singly and in combination, provide a range of problems which are solved by the campesinos (peasant farmers) through the differential application of common agricultural knowledge. In addition variation in the application of this knowledge is at times due to the inclination of the individual campesino (Sanders 1957: 109; 1962: 8).

Several of the major topographic variations within the Teotihuacan Valley proper are of importance to the agriculturalists farming the area. These include the flat valley floor, the adjacent gentle slopes and piedmont, the flat topped ridges in the southeastern part of the valley, and the steep hill and mountain slopes.

A consideration of the hydrography of the valley involves an examination of sources and distribution of water within the area. Ultimately all moisture is derived from rainfall. Sanders (1965: 24) has summarized certain significant features of rainfall in the area.

> The low ranges that define the Valley act as an obstacle to free movement of moisture-laden winds and reduce the annual rainfall to one of the lowest averages in the Basin of Mexico. At least four-fifths of the total rainfall falls in the period from June 1 - October 1. . . . The pattern of rainfall noted as characteristic of the basin as a whole, with brief, torrential, highly localized showers; late inception and internal droughts are nowhere as pronounced as in the Teotihuacan Valley. . . .
>
> Our impressions indicate that rainfall is somewhat higher, possibly by as much as 50 percent, on the upper slopes of the Patlachique Range and Cerro Gordo, with perhaps less of an increase on Chiconauhtla and Malinalco. This observation is based on the relative lushness of natural vegetation since meteorological stations are absent. Camphor forests and unusually good pastures are found on the summit of Cerro Gordo.

Rainfall which is not absorbed by the soil flows toward the now almost defunct lake system in the Basin of Mexico. Sanders has described the drainage

---

[1] The data incorporated into this paper came from a few major sources. Gamio (1922, TII) presented the earliest study of modern agriculture in this area. Sanders (1957) made major contributions in filling gaps in Gamio's materials. Millon and his co-workers (1962) have published a very detailed study on the permanent irrigation system of the Lower Valley. I have also incorporated data I collected on the north slope of Cerro Gordo in the spring of 1964 while supported by a Social Science Research Council Research Training Fellowship.

system of the Teotihuacan Valley proper (1965: 23).

> The Valley . . .is a hydrographic unit. Drainage is explosive and destructive, and all slopes have deep gullies or barrancas that carry runoff to the mainstream, El Rio de San Juan, which in turn empties into Lake Texcoco. The flow of water in all of the barrancas is sharply seasonal and even during the rainy season water usually flows only a few hours, or at most a few days, following the torrential showers. The Barranca de Los Muertos, Atlamajac o Ixtetes, Huixcololco, San Martin and San Lorenzo. . .are especially significant in agriculture, particularly the first two. All of the mentioned streams join the Rio de San Juan above the town of San Juan Teotihuacan.

In the Cerro Gordo-North Slope area the drainage pattern is similar but leads directly into the northern part of the Basin of Mexico.

A further source of moisture is present in the valley proper. In and near the town of San Juan Teotihuacan there is a group of springs, fed by sub-surface drainage primarily from the Patlachique Range. They provide 540 liters of water per second (Millon et al., 1962: 497) which flow into the Rio de los Manantiales. This stream ultimately joins with the Rio de San Juan to form a permanent waterway.

Thus there are three natural sources of moisture in the Teotihuacan Valley, rainfall, barranca drainage and permanent springs. These are not equally distributed throughout the area. Consequently, it is possible to understand some aspects of the modern agricultural system of the valley in terms of local responses to local topographic and hydrographic conditions.

LAND CLASSIFICATION

Gamio (1922, T. II) and Sanders (1957; 1965) have presented land classifications for the valley. Supplementing this data the author has collected data on land classification from the villages of San Cristobal Colhuacan and Santa Maria Maquixco el Alto in the Cerro Gordo-North Slope area. Although not stated in Gamio's work it appears probable that the system which he describes is based on an indigenous system of land classification. The materials collected by Sanders (1957) and Charlton are certainly statements of such systems. These systems are of importance since it is in accordance with them that agricultural knowledge is applied. They form one aspect of an ethnogeography which relates to differential distribution of agricultural techniques and patterns.

The inhabitants of the area classify lands according to several criteria which are used in varying combinations. These criteria include soil texture, soil color, soil depth, the accessibility and dependability of water for irrigation, topography and state of cultivation.

Gamio (1922, T. II) used soil depth, topography and water accessibility and dependability in classifying lands. He defined tierras delgadas (thin soils) as those with a depth varying from 10-15 cm. (1922, T. II: 105). Tierras profundas (deep soils) have a depth up to 6 m. The tierras profundas in the Middle Valley plain are soils with depths between 50-100 cm. The tierras profundas of the Lower Valley plain have a depth of at least one meter (Gamio, T. II: 105). Gamio also noted that the gradient in the Middle Valley plain was much greater than that in the Lower Valley.

With respect to topography Gamio designated two types of land, terrenos de ladera (slope lands) and terrenos de planicie (flat lands). The depth of the latter is much greater than that of the former (Gamio, 1922, T. II: 106).

Gamio also defined lands on the basis of texture and mineral content. He suggested that the lands southwest of San Juan Teotihuacan, as a result of the permanent supply of water and lower gradient, had become deeper and enriched with arena (sand), arcilla (clay), cal (lime), and humus. They approach, according to Gamio, the agronomic classification of tierras francas, or lands of a very high quality. He designated lands on the edges of the surrounding hills and in a zone stretching from San Martin de las Piramides to San Juan Teotihuacan as terrenos pedregosos (rocky lands) because of the quantity of stones present in them (Gamio, 1922, T. II: 106). He further stated that there was a great variation in the physical characteristics of the lands in the section of the valley he studied.

His classification also took into account conditions of water needed for cultivation. Terrenos de temporal are lands which have no other source of water but rainfall. The shallowness of the soil prevents the accumulation of humidity from season to season or year to year. These lands are generally found on hillslopes and include terrenos de ladera.

Terrenos de jugo (Gamio, 1922, T. II: 107) or Temporales de jugo (1922, T. II: 144) are lands, which, due to increased soil depth, or the availability of water from barranca runoff, permit the conservation of humidity until the planting of the following year. Such lands are particularly characteristic of the Middle Valley plain.

Terrenos de riego include the lands in the Lower Valley to the southwest of San Juan Teotihuacan which can be irrigated throughout the year with water from the permanent springs. In his land classification Gamio dealt only with the lands of the Lower and Middle Valley and emphasized those on the valley floor.

Sanders (1957) has presented a local system of land classification based on access to water, topography, soil depth, texture and color. One three-fold classification is based on a combination of access to water, soil depth, and topography and includes the following types.

> First, we have "tierra de humedad" which are deep soil, flat, vega (plain) lands in which a combination of humidity conservation techniques and temporary irrigation is carried out. Second, we have "tierra de temporal" which includes hillside, low slopes or thin-soil flat-lands where humidity conservation methods are impracticable. Finally, there is "tierra de riego" or deep-soil flat lands under permanent all-year-round irrigation. (1957: 122).

A second three-fold classification which he has described is based on soil color and soil texture. "Local farmers point out three basic types: (a) loams (migajon) of the Middle Valley; (b) tlatel-stone and earth mixed as in the archaeological zone; and (c) black earth (tierra negra) in the flat lands of the Lower Valley." (1957: 105).

I collected data on land classification in the villages of Santa Maria Maquixco el Alto and San Cristobal Colhuacan. This system is quite similar to that used in the Teotihuacan Valley proper with some minor modifications. Lands are first classified as being either terrenos arriasos, lands which produce nothing except maguey or pasture, due to steepness or erosion, or terrenos de cultivacion, all lands which are planted with edible or salable crops.

Terrenos de cultivacion are further subdivided into a number of categories based on soil color and content, access to water and soil depth. Those based on soil color and content include lama amarilla, which consists of eroded soil and tepetate redeposited in terraces; tierra negra (black soil) found in a number of older fields which have collected humus through some floodwater irrigation, accidental or designed; and tierra blanca (white soil) which has a high percentage of tepetate in it. A particular category tierra cenizuda refers to soil which has a high content of ashes due to location near abandoned residences such as the Hacienda San Cayetano or near still occupied residences within the villages.

Using water supply and soil depth as criteria, two further classifications of land types are defined by the local inhabitants. These are tierra de temporal, shallow soils depending on rainfall alone for moisture, and tierra de humedad, deeper soils which receive runoff directly from the hills or through a barranca system. All presas (terraces located within barrancas) and many, but not all, terraces are classified as tierra de humedad. A more detailed classification of tierra de humedad revolves around the use of the term migajon (very good agricultural soil) to designate superb tierras de humedad. Those which are considered full migajon include presas with a minimum depth of 1.5m.

and are located very close to Cerro Gordo so that any rainfall, even if of short duration, will reach them in the form of runoff from the hill. On the basis of the amount of water, the depth of the soil, and the type of soil, the inhabitants classify lands into levels of quality of migajon. Thus terraces below the jaguey which receive water from the overflow will have a higher classification in terms of migajon than those which are immediately above it. Generally speaking the terraces highest on the slopes of Cerro Gordo which receive the most water and lama are considered, with the presas, to be the best lands available.

Before beginning a discussion of features of contemporary agricultural systems a summary, by Sanders, presenting a scientific description of the soils of the area, is quoted below.

> The sub-soil of the Teotihuacan Valley consists of a material locally called "tepetate", a hard, compact, crumbly, earth-like formation that is relatively impervious to water in contrast to the soil above. According to Gamio's field study, it is composed of volcanic ash and redeposited by fluvial action.
>
> The organic or "A" soil layer above the tepetate varies considerably in thickness over the valley and is generally loamy in texture. Near the barrancas and lake shore, clay textured soils are common and in badly eroded areas sandy textured soils predominate. In general, soils in the plains are deeper and more finely textured than those on the slopes; soils in the Lower Valley are deeper and finer textured than those in the Upper Valley. Most of the soil in the valley is easily worked with simple tools and has extraordinary capacity for storing water. In areas where soil depth exceeds one meter, water may be stored for several months using special techniques of working the soil. The less permeable layer or tepetate below acts as an artificial tank floor.
>
> Soils are generally classified as "Chestnut" in most of the valley and Chernozem in the alluvial plain of the Lower Valley and Delta. Such soils, before degraded by intensive cultivation, are characterized by fair to rich concentrations of organic matter, nitrogen and lime, and have a high concentration of potassium and phosphorous. Furthermore, in arid climates like that of the Teotihuacan Valley, there is a general tendency for water to percolate upward in the soil bringing fresh supplies of plant nutrients to the surface. Today, with varying degrees of intensity of cultivation and application of soil restoration techniques, the soil varies considerably in the presence of those nutrients and greatly degraded soils are common. In general, soils of the Teotihuacan Valley are fertile, capable of sustained cultivation, and rarely fallowed. The major soil factor that inhibits or limits productivity is depth. (Sanders 1957: 24-25)

SOIL AND WATER MANAGEMENT TECHNIQUES

In this section attention shall be directed to the various techniques of agriculture applied in the Teotihuacan Valley. A number of techniques for the conservation and control of both water and soil are utilized. The distribution and application of these techniques relate to specific features in the natural environment.

1. Permanent Irrigation

The existence of permanent springs at San Juan Teotihuacan provides a source of water for the irrigation of the Lower Valley plain. The system was in existence at the time of the Conquest and undoubtedly is prehispanic in origin. Gamio has stated that there were over one hundred springs in San Juan Teotihuacan and in the barrios of San Juan Evangelista and Puxtla (1922, T. II: 87). Members of his project estimated the total volume of the springs in the month of December, the end of the rainy season, to be 1,500 liters per second. For the year they estimated a mean of a little less than 1,000 liters per second. The total amount of water produced by all the springs through the year that could be used in agriculture is estimated at 31,000,000 m^3 (1922, T. II: 87).

Sanders noted, at the time of his study, that the flow of water from the springs had decreased to 588.6 liters per second (1957: 118). Millon et al. have recorded a further decrease to 540 liters per second (1962: 497). This decrease may be related either "to the overall dessication of the Valley of Mexico during this century." (Sanders 1957: 118) or "to perforation of artesian wells up-valley by large landowners." (Sanders 1965: 36). During the rainy season (May to October) the runoff carried by the barrancas adds to the amount of water available for irrigation in the Lower Valley. The amount added has never been estimated in considerations of the system.

The water from the springs is collected by small earth ditches into a single canal, the Rio de los Manantiales, which flows to a place below the barrio of Maquixco called "La Taza". Here it divides into two main canals. The Canal of San Jose flows on the west side of the Lower Valley and has an average flow of 287.32 liters per second. The Canal of San Antonio has an average flow of 200.26 liters per second and runs along the east edge of the Lower Valley. The Rio Grande, formed by the junction of the Rio San Juan and Rio San Lorenzo enters the Canal of San Antonio just below "La Taza". In the rainy season the barranca runoff mentioned earlier enters the irrigation system through this canal. (Sanders 1957:119), 1965: 36; Millon et al. 1962: 497).

> There are also two smaller canals that derive their water from local springs at Maquixco, the canal of Texcalac (50.36 liters per second), and Cadena (12.66 liters per second). Near Atlatongo are some very small springs at a place called "El Tular" that provide an additional two liters. (Sanders 1965: 36).
>
> The Canal de San Jose forms the northern and western limits of the system. Its waters rejoin the canals of the central and eastern parts of the system at the major junction north of Cuanalan. The single canal flowing south from this point, while it bears the name Rio Grande, is fed in large part from the Canal de San Jose. . . . The Canal de Texcalac empties into the Rio Grande northwest of

> Atlatongo; its waters thence flow south to the Las Cortinas sluice, from which they are diverted to irrigate the lands of San Bartolo, Acolman and Sta. Maria Acolman. The Rio Grande itself carries very little water south of Las Cortinas during most of the year. The Canal de San Antonio begins at La Taza, southeast of Maquixco, flows southwest to El Temescal, at which point it passes beneath the Rio Grande, after which it flows southward to a point north of Xometla. There it divides, forming a number of subsidiary canals, which sometimes bear the name of the canal and in other cases are called "rivers", as, for example, the Rio de Xometla. The Canal de Cadena. . . is the shortest canal in the system, and carries very little water. It runs from San Juan Teotihuacan to Maquixco, on the south side of the highway. Thereafter it enters the Canal de San Jose. The average volume of water carried by each of these canals at their sources is as follows: Canal de San Jose--78.5 gallons per second; Canal de La Texcalac--14.2 gallons per second; Canal de San Antonio--43.2 gallons per second; Canal de Cadena--6.8 gallons per second. The average volume of water produced by the springs feeding these canals is 142.7 gallons per second. (Millon et al. 1962: 502)

Below the springs, in the alluvial plain, the water is distributed through a network of secondary and tertiary canals. Technically the irrigation system is simple and is operated by a primitive technology. It is based ultimately on the permanent springs and the gradual gradient of the Lower Valley plain which permits the creation of a drainage type irrigation system. All of the canals used are simple earth ditches. Since there is a very slight gradient from northeast to southwest careful grading is not necessary.

Organization of the System

When Gamio studied the Teotihuacan Valley the irrigation system was controlled by four large haciendas, Cadena, San Jose, San Antonio and Santa Catarina (1922, T. II: 92). Since then, as the product of the agrarian reforms, control of the water has passed to the Federal Government of Mexico. At that time most of the land irrigated by the system was turned over to 16 villages (3373 hectares out of a total 3652), the remainder belonging to six haciendas or ranchos (Sanders 1965: 36). Both Sanders (1957) and Millon et al. (1962) have described in some detail the present organization of the units within the water distribution system.

Under the federal Ley de Aguas, which directs irrigation systems in Mexico, all persons holding irrigated land in this system belong to an organization called the Junta de Aguas de los Manantiales de San Juan Teotihuacan (Sanders 1957: 119); Millon et al. 1962a: 497). Members of the Junta include representatives of each of the ranchos or haciendas receiving water, representatives (usually the president) of each village ejido, and an elected representative from each pueblo or barrio with irrigated private property.

> Ideally, Junta elections are held annually in December, the call for the election coming from the agent of the federal department of irrigation and water resources, a department of cabinet rank called Recursos Hidraulicos. After the elections the Junta members and certified as elected by the representative of Recursos Hidraulicos

and thereafter constitute the incoming Assembly of the Junta.

> The Assembly then meets to elect an Executive Committee for the Junta, consisting of a president, a secretary and a treasurer. In practice the president of the Junta is always an ejido representative. We were told this was because ejido lands constitute the largest body of irrigated land in the Valley. It is also customary for the secretary of the Junta to be a pequena propiedad representative and for the treasurer to be a rancho or ex-hacienda representative. In other words, the three types of landholding are represented on the Executive Committee, with the most important post held by an ejido representative. (Millon et al. 1962: 504)

The main purpose of the Junta is to implement the federal water regulation laws. It has no power to change them. The Executive Committee of the Junta directs the distribution of water to members of the system in accordance with regulations established at the time of federal appropriation of the water and lands. These are based on the recommendations of hydraulic engineers sent out to assess the situation. "The water is very carefully distributed and administered by a time clock system in which each represented unit (ejido, pequena propiedad, hacienda) receives water according to the size of its holdings." (Sanders 1957: 120). Under this system it "was left to the Junta representatives in each village to decide how it was to be divided in consultation with the landholders and ejido representatives involved." (Millon et al. 1962: 508).

Although the Executive Committee of the Junta organizes the policing of the system and has the power to fine individuals guilty of violating water allocation regulations, water is frequently stolen through the use of small earthen diversionary dams. Millon et al. have reported a particularly significant conflict situation between water users in the upstream part of the system and those in the downstream section which they suggest is a result of inadequate water in the system. Agitation by persons in the downstream part of the system led to the issuance of a new water regulation for the valley by the Secretary of Recursos Hidraulicos in the summer of 1959. (Millon et al. 1962: 507-508).

The new water regulation deals with the problem of distributing water to individual landholders after it has been allocated to the larger unit. Essentially it abolishes the practice of allocating water to the pequena propiedad lands of a village as a whole. "The new principle of water allocation holds that each landholder should receive water for irrigation in proportion to the amount of land he owns or has use rights to, that is, a like amount of water for a like amount of land within any given system." (Millon et al. 1962: 508). Thus the informal allocation of water to individual users within a village is effectively abolished for the holders of private property. The ejidos are affected by this regulation in that under it their water supply has been reduced from 15 to 30 percent for three-fourths of the ejidos. Each ejido however continues to divide the water among its members informally. (Millon et al. 1962: 511).

Millon et al. have reported opposition to the new regulation on the part of small landholders "because, with the primitive methods now used to bring water to the land, brief periods of water allocation of the order of one to five minutes are virtually valueless. . . ." (1962: 511)

The new regulation also reduced Atlatongo's permanent water right from 30 liters per second to 18.3. The village had received these special rights because of documentary proof of their claim to pre-hacienda period water rights. As a result of these rights Atlatongo was a focus of the conflict within the irrigation system leading to an early enactment of the new regulation. (Millon et al. 1962a: 506-512).

Both Sanders (1957) and Millon et al. (1962a) have presented tables with data on land tenure and water distribution within the irrigation system. The table used by Sanders (1957: 120-122) is presented below.

Table 1

DISTRIBUTION SYSTEM

Landholding Unit	Liters A Second	Duration			Number of Hectareas Irrigated
		Days	Hrs.	Mins.	
Canal of Cadena					
Hacienda Cadena	12.66	10	6		30.1
Ejido San Juan	12.66	19	18		57.96
Canal of Texcalac					
Ejido San Bartolo	50.36	3	10		40.0
Private San Bartolo	50.36	2	6	30	26.50
Ejido Santa Maria	50.36	6	20	15	80.00
Ejido Calvario	50.36	4	15		54.0
Private San Bartolo	50.36	4	6	30	50.0
Private Calvario	50.36	8	13	30	100.0
Canal San Antonio					
Ejido Atlatongo	200.26	1	5	30	47.51
Hacienda Santa Catarina	200.26	3	10		175.28
Private San Bartolo	200.26	1	7		60.0
Ejido San Bartolo	200.26	2	5		102.5
Ejido Xometla	200.26	4	20	45	205.72
Private Xometla	200.26	2	9	40	101.28
Ejido Calvario	200.26	1	3	15	90.00
Private Calvario	200.26	1	13		65.00
Ejido Tepetitlan	200.26		19	45	32.00
Ejido Cuanalan	200.26	7	19	45	303.0
Ejido Tepetitlan	200.26		16	45	26.96
Hacienda San Antonio	200.26		4	30	7.19
Ejido Chipiltepec	200.26	1	5	15	47.00
Canal of San Jose					
Ejido San Bartolo	287.32	1	18	15	117.00
Ejido San Marcos	287.32		20		52.8
Hacienda San Jose	287.32		4	30	11.0

Table 1-Continued

Landholding Unit	Liters A Second	Duration Days	Hrs.	Mins.	Number of Hectareas Irrigated
Ejido Santa Catarina	287.32	1	14	15	96.7
Ejido Calvario	287.32	1	8		81.00
Private Santa Catarina	287.32	1	8	45	79.00
Ejido Cuanalan	287.32		21	15	50.00
Private Tepexpan	287.32	3	19	15	211.28
Ejido Tequisistlan	287.32	2	12	30	140.00
Ejido Tepexpan	287.32	2	7	45	128.94
Private Tequisistlan	287.32	1	8	45	76.00
Private Nexquipayac	287.32	1	15	30	91.00
Ejido Nexquipayac	287.32	3	4		176.00
Hacienda Ixtapan	287.32	1			55.00
Hacienda Tepexpan	287.32		5		1.0
Private Ixtapan	287.32	1	5	30	68.56
Ejido Ixtapan	287.32	4	18	45	265.94
Ejido Altatongo	38.0	(permanent flow)			240.00

The sizes of the irrigated holdings are summarized below:

Table 2

SIZES OF IRRIGATED HOLDINGS

Landholding Unit	Ejido	Private Holding	Total (hect.)
San Bartolo	259.50	136.50	396.00
San Maria	80.0		80.0
Calvario	235.0	165.0	400.0
Atlatongo	287.0		287.0
Xometla	206.0	101.0	307.0
Tepetitlan	59.0		59.0
Cuanalan	353.0		353.0
Chipiltepec	47.0		47.0
Santa Catarina	97.0	79.0	176.0
Tepexpan	129.0	211.0	340.0
Tequisistlan	140.0	76.0	216.0
Nexquipaya	176.0	91.0	267.0
Ixtapan	266.0	68.0	334.0
San Marcos	53.0		53.0
San Juan	58.0		58.0
Total - village holdings			3373.0
Hacienda holdings			279.0
Grand total - irrigated land			3652.0

The Executive Committee of the Junta also directs the cleaning of canals and the upkeep of water diversion devices. The main canals and the springs are cleaned annually in September and October. The Executive Committee advises the Assembly representatives in each village to send an allotment of men. Each village has the obligation to clean portions of the main canals. Sanders (1965: 37) has noted that the total number of workers may reach as high as 800. The secondary and tertiary canals are cleaned by smaller groups composed of the campesinos who use the particular canal. (Sanders 1965: 37; Millon et al. 1962a: 504).

> The work of the Committee is supported financially from a fund made up of what is collected in fines and a small water tax paid to the Committee by each water user according to the volume of water used. This sum is used to pay the salaries of the guards and small stipends to the members of the Executive Committee. None of this money is turned over to Recursos Hidraulicos or to any other branch of the federal government. (Millon et al. 1962: 504-505)

Conflict and Cohesion in the System

Millon et al. (1962) and Millon (1962) have characterized the permanent irrigation system of the Lower Valley as one with strong disruptive characteristics and with only weakly developed mechanisms of cohesion.

> The system has been riven by conflicts between downstream and upstream users of irrigation water because there is an insufficient supply of water for the minimal needs of all. Open conflicts have broken out on several occasions, requiring the intervention of the federal government. Disputes arising from the conflicting needs of upstream and downstream landholders, large and small holders, and other such divisions have so weakened the valley that its population has been unable to effectively resist a new water regulation the federal government has recently imposed. The new regulation is completely unworkable from the point of view of the holder of a small plot or plots of land; it is workable and reasonable only for the larger landholders.
>
> The Valley of Teotihuacan system, which has been torn by increasingly severe conflicts, is, in short, a centralized system created and supervised by the federal government, in which allocation procedures never have been adequately institutionalized. (Millon 1962: 79-80)

Millon et al. do indicate that within each village there is strong cohesion on matters concerning the distribution of water. However they suggest that "above the local community level cohesive forces appear to be diffuse, subtle and limited in scope." (1962: 516). They recognize that the Junta performs important cohesive functions but does so inadequately due to its limited power (1962: 517). The only other means of cohesion in the irrigation system they suggest is the Fiesta of El Divino Redentor (the Divine Redeemer). This is an important religious fiesta held in the parish church of San Juan Teotihuacan, July 19th, or 20th each year. All the communities in the irrigation system are invited and requested to provide financial support for the

fiesta. The image of El Divino Redentor is believed to have power to bring water when it is needed. There is some evidence of parallels between his activities and those of aboriginal rain gods.

Despite the unity involved in the fiesta Millon et al. do not believe it to be a strong integrative force. "That it functions to bridge the distance among individuals and among communities is plain. It is also plain that in this supporting role it does not possess sufficient strength adequately to contain the sources of conflict." (1962: 519).

Sanders (1965) recognizes the disruptive qualities of the system which Millon and his co-workers have described. However he suggests that "Characteristic then of the system is a pyramid of cooperative work gangs that act as a powerful integrative factor on the infra-community, community, and supra-community levels." (Sanders 1965: 37). He recognizes thus that there exist both disruptive and integrative factors within the system but would assign a greater significance to the integrative factors than would Millon et al. The exact balance between these forces has not been adequately defined in any publication or research to date.

Agricultural Significance of the System

The irrigation system is of great significance in terms of modern agriculture. Rainfall is light in quantity, sharply seasonal. Five-sixths of the annual precipitation falls between May 1st and October 1st. The date of inception and closure of the rainy season however varies considerably from year to year, as does the total amounts of rain. Internal droughts during the rainy season are a further problem. These problems are further aggravated by a frost season which normally begins in October and ends by March 1st, but like the rainfall there is a considerable range in these dates. Normally, rainfall is adequate for cropping, but the combination of late inception of the rainy season and early frost has caused heavy damage and even catastrophic failures to crops in the past. The solution is irrigation. The major irrigation technique used in the system is a single pre-planting flooding of the fields to provide an earlier start for the crops. This technique is referred to by Mexican agronomers as medio riego and it permits the use of limited water resources over as large an area as possible (Sanders 1963: 14). Often there is no succeeding irrigation. The necessary moisture is supplied by summer rains. For cropping during the dry season two to three irrigations are required and because of the frosts only certain crops may be grown.

Given the relatively low output of the springs it is necessary to begin flooding in December if all areas are to receive some moisture. In the case of early flooding the land is worked with a variety of techniques to conserve the humidity until the planting of maize begins in March. According to Sanders (1965: 37) the period during which irrigation can be carried out and maize still planted runs from December 1st to June 30th. The planting of beans, which mature earlier than maize, and hence can be planted later, relieves some pressure on the irrigation system.

> What irrigation does is to permit a pre-June sowing, and thus to avoid a fall frost. It also insures at least part of the area against mid-season droughts. As a result the highest maize yields

> in the valley are from this section, heavy crop losses nearly absent and even partial losses only occur occasionally. (Sanders 1963: 14)

The assignment of the date of the pre-planting irrigation to individual farmers varies each year. For maize the highest productivity is acheived when the land is irrigated in April and planting occurs in May and this procedure therefore insures an equitable distribution of water.

Other crops are raised in the irrigated plain. The recent expansion of dairy cattle is associated with the planting of fields in alfalfa and clover. In addition the introduction of wheat (which is frost resistant) has permitted double-cropping of a high percentage of the land.

> The usual pattern is to plant maize in the spring, followed by wheat in the fall, if the farmer has two or three water allotments in a given year, followed by a single barley crop the second year without irrigation. The exact order is a highly flexible one based on the number and timings of irrigations in a single year. If maize and wheat are to be grown in a single year, at least three rations of water are required since wheat grown during the dry season would require two irrigations (pre-planting and again during the growing season). Sanders (1965 : 37).

Other Permanent Irrigation Systems

The Lower Valley irrigation system is the only one in the valley based on a naturally occurring flow of water which comes to the surface without requiring pumps or excavations. According to Millon et. al. the modern system covers the same area as the 16th century irrigation system (1962: 505).

Through the use of well drilling equipment in the valley, a number of haciendas and ranchos have introduced small irrigation systems within their property. The Rancho La Ventilla has such a system. One of these is found in the old Hacienda of Hueyapan, recently purchased by villagers from San Pablo Isquitlan. The water is supplied by a pump and is used to irrigate twenty-eight hectares of land. Other small systems occur in the valley but data is inadequate to comment further on them. The system of the Hacienda Hueyapan will be described in detail later in this paper.

2. Chinampa Cultivation

In the area immediately around the springs the water table is extremely high, often less than one meter below the surface of the ground. Gamio noted that the problem here was one of too much, not too little, water. In order to grow crops in this area a system of drainage has been carried out. Gamio describes one project, carried out by the Hacienda Santa Catarina, to drain the stagnant water from swamps at Tepozontitla. Drainage was achieved through the use of a buried tube which dried up the swamps making them fit for agriculture and also provided a supply of 40 liters of water per second to irrigate the lands of the hacienda (Gamio, 1922, T. II: 89).

A more traditional peasant solution to the problem is what Sanders referred to as chinampa (because of the many similarities to a system of cultivation once widely practiced in the southern part of the Basin of Mexico). The total area involved has been estimated as no larger than 100 hectares (Sanders 1965: 44). In order to cultivate lands in this area the farmers dig ditches around long rectangular pieces of land creating fields similar in size and shape to the true chinampas. The ditches usually have a constant supply of water through seepage.

The chinampa system practiced around the springs makes use of the condition of very high soil humidity (a rare occurrence in this area). This reduces crop loss through early frosts or droughts and supplies runoff water to the alluvial plain below the springs. Sanders has noted a "focus on truck gardening, intensive land use with seedbeds, scoop irrigation and hand techniques of working the soil." (1965: 44). These techniques, the emphasis on vegetables and the presence of huejote trees on the edges of the ditches heighten the similarities of this system to the true chinampas. Animal fertilizers are used, due to the lower organic content of the soil, as compared to true chinampas from the Xochimilco area (Sanders 1965: 44).

Although the system did not require the use of irrigation in the past the recent drop in the water table has brought about changes both in the crops grown and the introduction of irrigation to the system. Maize can be planted early with the existing level of humidity in the soil and does not require irrigation. Much of the area has been converted to the growing of maize. The campesinos who still plant vegetables have rights to use water from the spring system since the existing level of subsoil moisture cannot maintain standing water in the ditches that would normally provide humidity for irrigation. (Sanders 1965: 44-45) "Probably the highest maize yields in the Teotihuacan Valley are achieved here. Because of the humidity of the soil, crops may be planted earlier and grow faster so that the first harvest of the year occurs on these lands." (Sanders 1965: 45)

3. Floodwater Irrigation

This type of irrigation utilizes barranca floodwater from the hills. It requires a combination of shallow barrancas, deep soil (at least 50 cm. and preferably 1 m.) and flat or gently sloping terrain. Floodwater irrigation occurs in many places within the Valley where the proper combination of features is present. It also supplies extra water to the permanent irrigation system of the Lower Valley. The greatest application of floodwater irrigation occurs in the Middle Valley alluvial plain. (Sanders 1965: 33).

> "Irrigation in the Middle Valley is very irregular as it depends on rainfall in the neighboring hills. It is based on three important points: (1) the rainfall in the surrounding hills often falls sooner than in the valley floor, permitting pre-season sowing; (2) the rainfall is usually heavier than in the valley proper and often when rains cease for extended periods during the rainy season it may rain quite heavily in the hills; and (3) the gradients of the lower slope permit simple irrigation systems to conduct this excess runoff from the surrounding hills. (Sanders 1957: 114)

Gamio (1922 T. II) has presented some estimates of the amount of water available for floodwater irrigation in the Middle and Upper Valley. He and his co-workers estimated a total area of more than 37,000 hectares drained by the Rio San Juan above the town of San Juan Teotihuacan. They estimated a minimum rainfall of more than 222,000,000 m^3 a year over this area. Sanders (1957: 108) has pointed out that this figure is an average rather than a minimum. An estimated 20 percent of this total runs through the barrancas, 30 percent evaporates and 50 percent is absorbed into the soil according to Gamio and his associates. Part of the absorbed moisture reappears in the form of the springs at San Juan Teotihuacan to supply the permanent irrigation system of the Lower Valley. The total amount of water estimated to flow through the barrancas during the rainy season is 45,000,000 m^3. It is possible, as suggested by Gamio and his co-workers, that the area of irrigated land in the Valley could be increased to 10,000 hectares with full utilization of both the springs and the barranca runoff. (Gamio 1922, T. II: 86-87)

The floodwater irrigation system utilizes a technique known as presa y caja to regulate the flow of water from the barrancas into the fields. It consists of a series of dams built across the barrancas to raise the water level to a point where it can be fed into canals. The canals in turn conduct water into the fields. The fields are prepared before flooding with bordos (embankments) of earth around them to form cajas ("boxes") to retain the water. The water remains in the field, thoroughly soaking it, and also deposits silt held in suspension. Gamio has indicated that the dams used can be characterized not as storage dams but rather as diversionary dams. His hydraulic engineers considered the gradient too steep and the soil too permeable to permit the construction of storage dams. (1922 T. II: 88) Sanders (1957: 113) has suggested that only the former factor is of importance since the tepetate provides a sufficiently impermeable base for jagueys. At the time of the Gamio study only the Hacienda Cerro Gordo had constructed storage dams and these had small capacities. This was due to the reduced gradient on the lands of the hacienda. (Gamio 1922: T. II: 88)

The dams are built of loose stones, masonry, or even earth, across shallow places in the barrancas. A heavy rain results in a large flow of water in the barranca. The Barranca de Maquixco has frequently flooded the road between San Juan Teotihuacan and the barrio of Maquixco. Similar flooding has occurred on the road from San Martin to Otumba as a result of overflow from the Barranca de Xalmeyo. The dams block the water which forms temporary ponds. One or two main canals (one on each side) are excavated behind the dam. The water flows through these main canals from the ponds and is conducted through a system of secondary canals to the individual fields. This is done through the construction of small temporary earth dams across the main canals. The same technique diverts water from the secondary canals into the fields. (Sanders 1957; 1965)

> Each field is surrounded by a low earth wall ("caja") varying in height from 30 to 100 cm. Each holding is completely inundated up to the level of the enclosing earth walls and the water then led onto the next field. Fields, which were originally irregular in surface, are often leveled off and trimmed down to prevent uneven drainage and larger holdings are often divided up into sections by low earth walls to further equalize the flow of water. (Sanders 1957:114)

An examination of the main canals, particularly those running from the dam in the Barranca de Terrenates just below the Hacienda Hueyapan, indicates that the principle of gradient is well understood and applied.

Organization of the System

Each dam and canal complex is usually small and directs water to an area of 50-100 hectares. Within a major barranca there may occur several dam-canal complexes. Once water has been used by the first dam the wooden floodgates are opened and the water moves down to the next dam. (Sanders 1957: 115; 1965: 34-34) Today many of the dams are silted in, the floodgates broken or inoperable, and only the primary canal inlets are kept open. This condition is due undoubtedly to the end of hacienda control of many of the systems and a subsequent decline in their upkeep. I have listed below the major dams as described by Gamio (1922 T.II: 89-92) and Sanders (1957: 116-118)

Barranca de Terrenates - This barranca collects drainage from the north slope of Cerro Gordo and from a number of smaller hills adjacent to Cerro Gordo. Between the Hacienda Hueyapan and the junction of this barranca with the Barranca de las Canteras (Acholoico) there are three dams.

1. At the Hacienda Hueyapan there is one dam, constructed by the hacienda, built of masonry. Today it has become completely silted in.

2. A second dam is located 400 m below the first. It also is of masonry and was constructed by the hacienda. It serves the lands of the hacienda casco and the ejido lands of Santiago Tolman.

3. A third dam is found 800 m below the second. It too is of masonry, has silted in, and had inoperable floodgates, as of 1964. Since it provides water for the ejidos of Santiago Tolman and San Pablo Isquitlan it was probably constructed by the hacienda. Some water does reach the private property of San Pablo.

Barranca de las Canteras (Acholoico) - There are two stone dams of masonry construction in this barranca. One is located just north of the road between Santiago Tolman and the Hacienda Hueyapan. The other is just south of this same road.

1. This dam located north of the road has one canal which leads water into the private property of San Pablo Isquitlan and Santiago Tolman, and to the jaguey of San Pablo. It is silted in today.

2. The dam located below the road has one canal which leads to the left into what is now the ejido of Santiago Tolman. It probably was constructed by the Hacienda Hueyapan.

Barranca de Atlamajac - This barranca is formed with the junction of the Barranca de Terrenates and the Barranca de las Canteras (Acholoico). Gamio mentions that the Hacienda Cerro Gordo constructed two storage dams and one diversionary dam in this barranca. Sanders mentions the construction only of two dams. It is possible that one of the storage dams has been destroyed and that one has been reutilized as a diversionary dam.

1. The two storage presas had a capacity of 800,000 m^3 of water.

2. The diversionary dam built by the Hacienda Cerro Gordo measured 113 m in length, 10 m in height in the deepest part of the barranca, and 1 m thick at the top. Three floodgates were each 2 m wide and shut with tree trunks and beams. The canal which directed the water to the hacienda lands between the Barrancas de Atlamajac and Xalmeyo had a capacity of 300 liters per second.

After the agrarian reforms all the dams were abandoned. Recently the ejido secretary of San Martin obtained the help of campesinos from his community and that of Santiago Tolman to repair one dam and to clean out the lead canals. Although it is possible that this dam is a storage dam it is more likely that it is the diversionary dam.

Barrancas de San Marcos and El Rincon - At the junction of these two small barrancas north of San Martin the Hacienda Cerro Gordo constructed one storage dam with a capacity of 200,000 m^3 of water, which, according to the owner, would provide adequate irrigation for 340 hectares. According to Sanders this dam is in only partial use by the campesinos of San Martin today.

Barranca de Xalmeyo - The Hacienda Cerro Gordo also built a diversionary dam on this barranca at the junction of the barranca and the road to Tulancingo (a Colonial Road).

Barranca de los Muertos (del Muerto) - As Sanders has pointed out, this barranca heads in the foothills of the Sierra Nevada and thus has a greater volume of water than any other in the valley. It runs through rich flat lands for most of its course and supplies water to most of this area through a series of six dams. "The dams were constructed and are maintained by the villages of San Martin de las Piramides, San Pablo Isquitlan, Santiago Tolman, Cuahutlazingo and San Francisco Mazapan." (Sanders 1957: 117).

1. This is a small dam located slightly west of the Ferrocarril Mexicano (National Railroad) crossing. According to Gamio one canal led of to the left to irrigate the lands of San Martin. On the basis of my studies further down the barranca I doubt that this canal led to the lands of San Martin but rather suspect that it ended in the lands of Cuahutlazingo. At the time of Gamio's study the canal could carry 120 liters per second and the dam raised the water level forty cm.

2. The second dam is 1,200 m. downstream from the first and according to Gamio irrigates the lands of Santiago Tolman. As shall be shown later in the discussion of the San Pablo Isquitlan section of floodwater irrigation in the Middle Valley, water from both the second and the third dams (Gamio also assigns the water of the third dam to the lands of Santiago Tolman) flowed to the lands of San Pablo Isquitlan, Cuahutlazingo and San Martin de las Piramides.

3. The third dam is 200 m below the second. Both dams are built of masonry and are relatively short. Each has a uniform thickness of 80 cm. The second dam has two canals, one leading to the right, the other to the left. The third dam has only one canal and it leads to the right. Gamio

suggested that each canal had a capacity of 600 liters per second. Today both dams are silted in although the canals still function. Maize has been planted in the accumulated silt behind them.

According to Gamio the next three dams in the barranca irrigate the lands of San Martin de las Piramides and San Francisco Mazapan. They are all of similar construction each being built of stone masonry. The first differs from the others in having an inclination of 30 degrees from a true right angle. This reduces the angle (measured on the left bank) at which the dam crosses the current from the more common 90 degrees to 60 degrees. All the dams are built in narrow and shallow sections of the barranca.

4. This dam lies 800 m below the third dam. It has a length of 40 m, a height measured from the bottom of the barranca of 5 m, and a thickness of 1 m. The reinforcing buttresses are also 1 m thick. Between the buttresses there are four gates, each 2 m wide. These are shut with tree trunks and beams.

5. The fifth dam is 200 m below the fourth. It measures 70 m in length, 1.50 m in height (from the bottom of the barranca) and has a thickness of 60 cm. It has two gates, each 1.50 m wide, both being closed with beams.

6. The final dam in the barranca is located 800 m below the fifth. This dam is 50 m long, 2 m high, and has a wall which is 80 cm thick. There are four gates in the wall, each 1.20 m wide. They too are closed with tree trunks and beams. Below this dam the barranca joins the Atlamajac to form the Rio de San Juan.

Gamio has mentioned that canals depart from both sides of these dams. He described the ditches as very irregular in cross-section. They averaged 2 m in width and 60 cm in depth. Each could carry 600 liters of water per second.

Barranca Tlachichinamitl (del Ciego) - Gamio mentioned the presence of a dam named Las Compuertas on this barranca. The village of Santa Maria Coatlan at the time of his study had lost its rights to the use of this dam through the non-payment of a loan to the Hacienda Metepec. Both land and the dam were forfeited to the hacienda.

Two canals left the dam, one directly to the hacienda, the other to the lands which formerly belonged to the village. The capacity of the canals was 300 liters per second. The dam, built of stone masonry, was 12 m long. It had a height of 3 m. The three gates, each 2m wide, were shut with beams placed in special grooves in the dam. Usually the gates were kept open to prevent accidental flooding of the fields.

According to Sanders (1957: 118) this dam was built by the Hacienda Metepec and supplied water both to the hacienda and to the lands of San Francisco Mazapan.

Gamio mentioned the existence of other dams belonging to the Hacienda Metepec and constructed in other barrancas descending from Cerro Patlachique. These were not described since they were located outside the area under consideration.

Barranca de Metepec-Oxtotipac - Gamio has described the cooperation between the Hacienda Tlajinga and the village of San Sebastian in the construction of a dam to irrigate the lands of both. This was almost complete in 1922. The dam was built of stone masonry. It had a height of 12 m above the barranca bed, a width of 15 m and one gate 2.5 m wide.

According to Sanders (1957: 116) no new dams of any importance were constructed between Gamio's study and his own work in the same area. Both reached the conclusion that the system was far from complete and could use many more dams to irrigate the lands with the available runoff.

Conflict and Cohesion in the System

Sanders has mentioned that at the time of his study in 1954 there was "no formal organization of water control as in the Lower Valley." (1957: 116). This situation had not changed when I was in the area in 1964. Sanders has suggested that the lack of formal organization may be linked to the nature of the system. The irregularity of the water "made formal regulation of water distribution impractical. It is probably unnecessary anyway since there is normally either no water in a barranca or more than is needed." (1965: 34).

The water distribution system is based on the upstream landholding units taking as much water as they wish and then letting the rest pass downstream. Usually there is enough water for all in a situation of flash floods, or no water for anyone in a situation of drought. The only units with "really dependable irrigation are the haciendas, located well upstream, as they capture even the results of very light rains." (Sanders 1957: 115). The haciendas were located during the nineteenth century in areas near the headwaters of barrancas. This enabled them to claim first rights for jagueys and for irrigation purposes. (Sanders 1965: 34). "Arguments and fights, although infrequent, have often been bitter and at times violent, especially between the haciendas and the villages further downstream." (Sanders 1957: 115).

Cohesion in the system is provided by two sources; cooperative work groups on the village and inter-village level, and symbolic unity through participation in ceremonial activities. Dams are constructed and maintained by the cooperative labor of one or two villages and/or a hacienda. "Such cooperative groups, therefore, crosscut village membership." (Sanders 1965: 34). Lead canals are cleaned and maintained by the campesinos whose lands they serve. The work is done by communal work gangs. Informants in San Pablo Isquitlan stated that the ejiditarios cleaned the main canals once a year during the dry season. Similarly the earth dams are maintained by those who use them. The smaller dams and canals are cleaned by the individual campesino whose fields they serve.

The ceremonial activity which links several communities participating in the floodwater irrigation system of the Middle Valley is the fiesta and peregrination of Nuestro Senor de la Cana. On or about the 16th day of May each year this local Santito is carried from the church at San Martin de las Piramides where he remains through the year, to San Salvador Cuahutlazingo, San Pablo Isquitlan and the Hacienda Cerro Gordo, returning to the church in San Martin. The image consists of a large framed picture of Christ (ca. 1 $m.^2$) which is carried on a litter by four people and is covered with reeds (cana) and gladiolas. In both Cuahutlazingo and San Pablo a mass is held in the

local church. Both the mass and a fiesta are held in San Martin. At each community the procession is met by a large group of people who join it as far as the church. Some continue back to San Martin via the Hacienda Cerro Gordo. According to one informant the Santito is considered very important at this time of year when rain is needed and has powers to bring rain. Certainly he links the major communities with land irrigated by the floodwater system of the Middle Valley. There also is some similarity between his activities and those of Prehispanic rain gods. Data is unavailable on the antiquity of this fiesta and it is possible that it is a recent innovation. The reeds covering the picture and carried by some people into the church are of some interest since the Aztec week beginning 1 Reed was associated with the water goddess Chalchiuhtlicue (Vaillant 1966: 109). This Fiesta and the Fiesta of Divino Redentor in the Lower Valley both represent the symbolic unity between the communities dependent on an agricultural system of the greatest importance to them all. Unfortunately data is unavailable on the financial arrangements made for the fiesta in the Middle Valley.

Agricultural Significance of the System

The floodwater irrigation system of the Middle Valley and other localities has a similar significance for agriculture as the permanent irrigation system of the Lower Valley. It is used to avoid crop failure through drought and/or early frosts. "The system collects water from areas of marginal agricultural use and diverts it to areas of high productive capacity." (Sanders 1965: 34). The generally unreliable nature of water in this area has led to the development of additional techniques which are used to prepare the land to conserve the humidity. These are also applied to some degree in the Lower Valley but are most intensively developed for maize cultivation in the Middle Valley (Sanders 1965: 34). These will be described in detail in the section Techniques of Cultivation.

Sanders (1957; 1965) has stated that, after harvesting, the fields are given a thorough irrigation in October with the final rains of the year. In November and in January the fields are worked to conserve moisture.

> The depth of the soil, presence of the relatively impervious tepetate below, use of earth banks, careful plowing and rastreo, floodwater irrigation, and loose crumbly soil texture all facilitate the storage of water in the lower soil levels. The upper soil level acts as a dry mulch protecting the humidity below and by spring has the appearance of talcum powder. (Sanders 1965: 34)

Irrigation is also carried out in May, at the beginning of the rainy season, when it is needed to give the crop a good start after the stored moisture has been used up. Cultivation is carried out during the growing season to maintain downward drainage. Maize is usually sown in April. A variety of special sowing techniques are used to reach the layer of humid soil below. Some planting takes place as early as March. The moisture present in the soil will allow at least 60 days growth after germination without rain (Sanders 1957: 124). I have seen maize which was planted in March reach a height of 50 cms by the 24th of May (1964).

The most common crop grown in the floodwater system is maize. Barley and wheat are secondary crops and frequently rotated with it. Beans are planted with

the maize and occasionally squashes as well. With unusually fertile soils barley and wheat are planted between the rows of corn. Maguey are planted as defense against erosion. The system is very productive and the growth of crops is very rapid. I have seen maize in the fields of Cuahutlazingo in July (1964) which was almost mature. Yields vary as to microecological conditions and generally are lower than in the permanent irrigation system of the Lower Valley.

Although most highly developed in the Middle Valley floodwater irrigation is found throughout the valley. Elsewhere it is usually associated with other techniques of soil conservation such as terracing. It is used also as an extra source of water for the Lower Valley permanent irrigation system. In addition I have observed one case of floodwater irrigation practiced on the north slope of Cerro Gordo above San Cristobal Colhuacan where a canal led water from a barranca into adjacent fields. But this type of floodwater irrigation is not common there. In the northeast end of the valley, (southeast of Otumba), is a dam and canal system that led water from the upper reaches of the Barranca del Muerto into an jaguey of the Hacienda Tlaltehuacan.

A thorough examination of the valley would increase the number of examples of small, local floodwater irrigation systems. However, the area of the valley which benefits the most, in terms of increased agricultural potential, through the application of floodwater irrigation, is the Middle Valley alluvial plain.

The antiquity of the present day system is a matter of some uncertainty. In his earlier work (1957) Sanders suggested that the system was a very old one which was taken over by the Haciendas and only recently returned to the campesinos (1957: 116). More recently, however, he has expressed the opinion that the system is one which developed as result of Spanish conquest, depopulation, heavy erosion of the slopes and redeposition on the alluvial plain of the resulting silt. I would like to suggest that the floodwater irrigation system, in its present form at least, developed with the expansion of the haciendas in the middle of the 19th century after the passing of the Ley Lerdo.

The dams mentioned earlier has been located on the accompanying map (Figure 2).

4. Terraces

The presence of a raquitic vegetation, loamy soils and torrential rainfalls in the Teotihuacan Valley make the erosion of slope areas a serious problem. The construction of terraces is one of several related responses to the problem.

> The term "terrace agriculture" is applied here to situations when the terrain is sloping; where erosion is being checked by stone, earth or maguey structures to the degree that soil depth in slopes exceeds 20-30 cm., and where downslope drainage is controlled. As the archaeological data will demonstrate, there is reason to believe, that most of the gentle-medium sloping terrain in the Teotihuacan Valley that is today cultivated using the temporal system, was covered by complex and carefully constructed terrace systems in 1519. (Sanders 1965: 39).

Although terrace systems are present in several areas of the valley the systems on the North Slope of Cerro Gordo, constructed and maintained by the communities of San Cristobal Colhuacan and Santa Maria Maquixco el Alto are, the best examples of this soil and water conservation technique. The following description of various features of terraces and terrace systems is derived primarily from studies of those systems.

Although substantial segments of the Maquixco-Colhuacan terrace systems appear to be preserved remnants of pre-conquest systems enough construction is presently taking place to provide substantial data on building techniques. The essential technique requires the construction of a bordo (ridge) of earth parallel to the angle of the slope with magueys planted on the summit. Sanders has described a rather elaborate terrace construction procedure observed in the private property of Maquixco el Alto.

> 1. Excavation of a trench 30-100 cm. deep into the tepetate, parallel to the slope, the length of the future terrace.
>
> 2. Tepetate extracted from the ditch is then pulverized to manufacture soil.
>
> 3. A series of shallow pits is excavated at one to two meter intervals, about 30-50 cm. deep in a row just above the trench and paralleling it.
>
> 4. Young maguey plants are planted in each pit, which is then partially filled in with the crushed tepetate.
>
> 5. Blocks of tepetate, adobe, chunks of rock combined with earth are used to build a low wall between the maguey plants to form a continuous bank.
>
> 6. A lateral bank is constructed on each side of the terrace using the same method.
>
> 7. In some cases the surface of the tepetate for a width of five to 10 m. behind the bank is worked over with a pick to manufacture an initial layer of soil.
>
> 8. The bordo once constructed then acts as a trap to contain tepetate derived soil washed down from above.
>
> (Sanders 1965: 42)

An informant from San Cristobal Colhuacan states that after the building of the bordo a period of three years would elapse before enough soil would be collected to warrant calling the bordo a terrace. In the third year a second terrace would be started upslope from the first. The first would then be planted with barley, or upon occasion with beans.

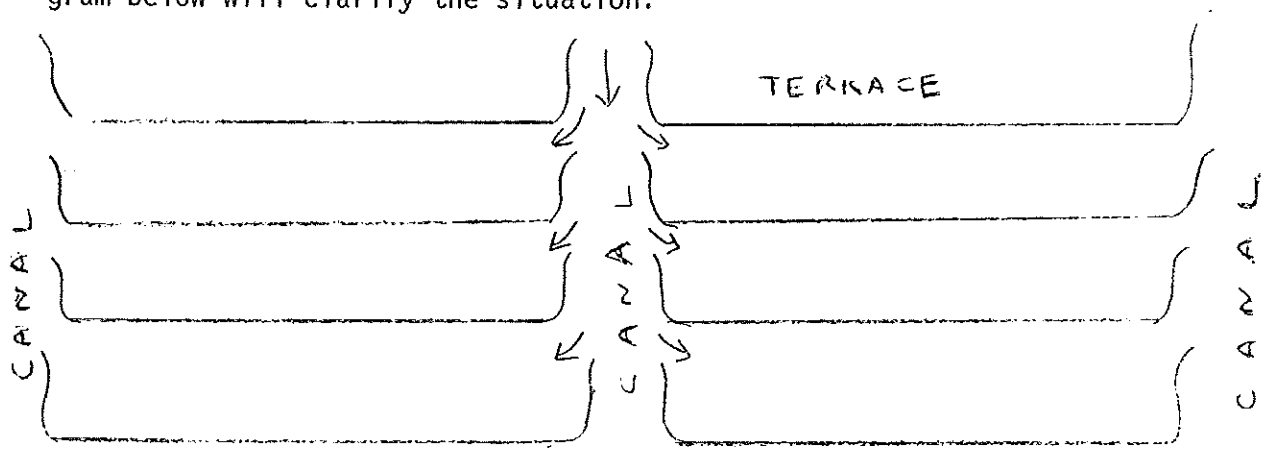
Once beans or barley are planted on the new terraces the loose, sandy soil (lama) gradually picks up some organic content. "After five to 10 years, the planting of barley and beans and growth of weeds adds organic matter to the soil, the soil depth has increased to 30-50 cm (from 10-20 cm) and the 'tresmeseno'

maize may be planted. After 10-20 years, highly productive terraces with deep, loamy, dark-colored soils have formed." (Sanders 1965: 42).

Although terraces do occur in isolation the usual arrangement is in vertical strips running downslope. Between the strips of terraces are found shallow canals which provide floodwater to the terraces when it rains. Terraces generally vary from 5 to 20 m in width but this is a highly variable feature depending primarily on slope angle.

Terrace height varies from 1-3 m. They are built slightly higher each year by banking more soil to take advantage of the water-deposited silt. (Sanders (1964a) has described the Colhuacan-Maquixco Alto terrace systems as follows:

> Terraces in all stages of growth, construction, maintenance and deterioration may be seen. There is considerable variation in soil depth, slope angle, crop use, techniques of erosion control and water conservation. . . .There is practically no free-flowing drainage off the slopes where terracing has been effectively maintained; terraces have sets of canals with self-flooding inlets. The terraces are arranged in roughly parallel groups running downslope, separated by main canals running between the sets of terraces. Each terrace on either side of the canal has an intake in the upper corner with low earth banks projecting into the canal to divert the water onto the terrace. The diagram below will clarify the situation:

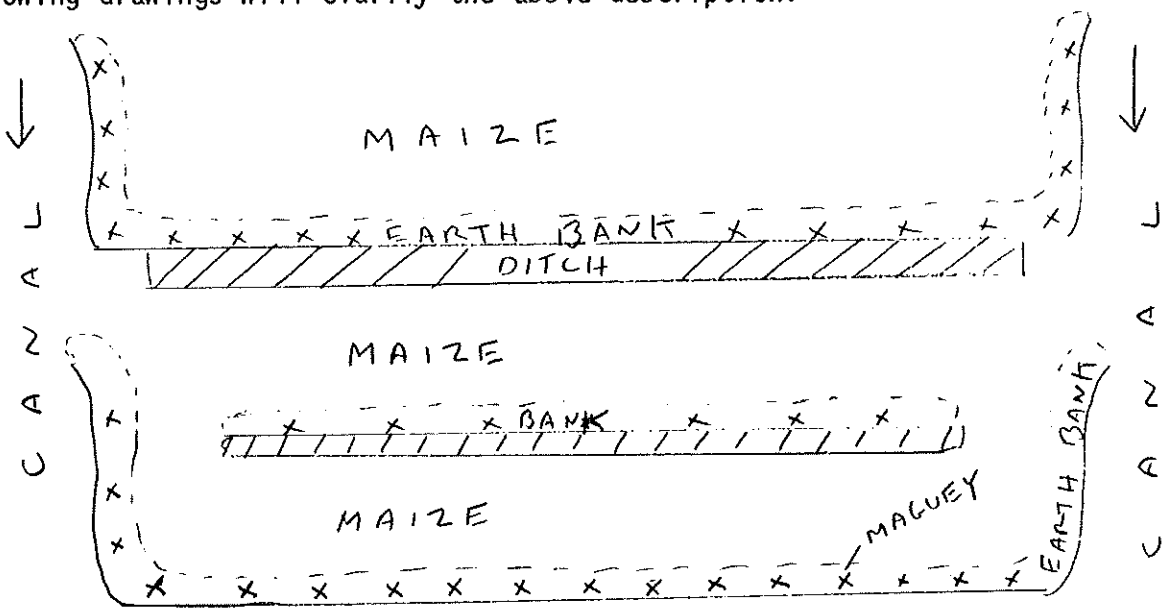


> All irrigation is of the flood-water type; there are no permanent streams of springs in the area today.

The most effective terracing occurs just east, north and south of the village of Maquixco Alto with the climax of the system represented by terraces lying along the big barranca north of the village and a small area southwest of the village and south of Cerro Tectlalo. In these areas soils frequently exceed one meter in depth. The front of the terraces possesses high earth banks planted in maguey or fruit trees; the surface of the terrace is completely level, and the lateral sides have earth banks as well to avoid lateral erosion and to retain water.

Each terrace has the canal intake noted above, and in many cases the water is diverted into a canal paralleling and occurring just below the

wall of the terrace immediately above it. The purpose of this is to break the force of the water and thus prevent gullying. Some terraces even possess a second ditch running along the terrace in the center, parallel to its long dimension and bordered by maguey, to further control erosion. Most terraces are from 10-20 meters wide; if wider, internal lines of maguey are planted to help level the terrace and prevent erosion. Stone terracing occurs but is uncommon. The following drawings will clarify the above description.



Most of the deep soil terraces are planted in maize or maize with wheat interplanted, plus habas and squash. Such lands are extremely productive with maize standing 2-4 m high when surveyed in September, 1963. The maguey and fruit trees along with weeds in the banks, and closely packed interplanted crops on the terraces gave the area at that time the lush appearance of a tropical jung.e (1964a: 1-2).

Destruction of terrace systems through erosion occurs easily and many examples are present in this area. If the side walls are not maintained then the terrace will erode from both sides into adjacent barrancas and gullies. Breaks in the lower banks also occur, washing out not only that terrace but also the one below it. "A deteriorating terrace is therefore a menace to the entire system." (Sanders 1965: 43). The construction and maintenance of terraces is correlated closely to the degree of terrace maintenance and the proximity of the residence of the landholder to his terraces. Other factors which might influence the condition of terraces include population pressure and the degree of dependence of the owner on agriculture for subsistence (Sanders 1965: 43).

As shall be described in more detail later in the discussion of the operation of the terraces on the North Slope of Cerro Gordo, terraces tend to grow old in terms of productive ability. This aging is a result of a reduction of water and lama, both captured by newer terraces located higher on the slopes of the hills. Thus although terraces may be perfectly maintained the construction of higher terraces can affect their productivity.

Organization of the System

According to informants, both in Maquixco el Alto and in Colhuacan, there is no supra household organization to direct the construction and maintenance of terrace systems in this area. There is no evidence of the existence of such organizations in any other area where terrace systems are present. Both initial construction and later maintenance depends on the landholder himself.

Informants at Colhuacan said that in order to construct a bordo 125 m long of earth and magueys, three to four men would have to work for a period of fifteen days. The interested landholder can organize this labor force in several ways. In one instance I observed a father and his three sons constructing a terrace on the slopes of Cerro Jaltepec. This type of labor arrangement seems to be the most common at Colhuacan. It is also possible to hire the necessary men at a rate of ten pesos a day per man. A final procedure is to contract with another individual to build the terrace. Such a person is usually skilled in terrace construction. The contract price would be less than the total amount needed to hire men by the day. Such contractual arrangements often ensure a more rapid completion of the terrace. When asked about the feasibility of constructing terraces higher on the slopes of Cerro Gordo one informant replied that it could be done but that it would take too much labor and money.

Agricultural Significance of Terraces

The construction of terraces on hillslope areas controls erosion, builds new fields with reclaimed soil, and provides an effective use of runoff water. Terrace systems frequently contain good tierras de humedad comparable to those on the valley floor. This is the result of a very impressive combination of soil conservation techniques and floodwater irrigation. Both surface runoff and barranca drainage are directed through terrace systems. In some systems barrancas are canalized and functionally integrated with the terrace.

Terraces thus convert severely eroded slopes into land which is both deep and moist. This land is used primarily for the planting of maize, although some barley does occur when the productivity of the soil has been decreased through erosion or capture of water and lama. It is possible to plant maize in the tierras de humedad in terrace systems as early as February or March. As in the case of the alluvial plain of the Middle Valley moisture conservation techniques are applied to the lands in the fall and early in the following year. Similarly rather specialized planting techniques are used to reach the humid soil. Thus the terraces provide villagers living in hillslope areas with land suitable for early planting and hence lessened chances of crop loss through early frosts.

Today terrace systems are located in several areas within the Teotihuacan Valley. The systems on the North Slope of Cerro Gordo are by far the best preserved and most impressive ones. These systems shall be described in more detail in the section on Agricultural System Operation. On Cerro Chiconautla is a system with terrace walls 1-2 m high and the entire drainage of the slopes on the hill is canalized.

Other areas of extensive terracing occur on the valley side of Cerro Maravillas, the lower and middle slopes of Cerro Malinalco, lower flanks of Cerro Gordo and on the lower slopes of the Patlachique

> range, especially south of Belen, Santiago Tepetitlan and the Hacienda de Tlajinga. (Sanders 1963: 13)

Along with his suggestion that terrace systems were widely spread over most of the gentle and medium slopes of the Teotihuacan Valley in 1519 Sanders has presented a possible post-Conquest history of terracing. After the Conquest the rapid decline in population, combined with the introduction of the congregacion policy, led to an abandonment of the hillside area, and their use for pasturing sheep and goats led to a rapid erosion of the existing terrace systems. Much of the hillslope region was restored during the nineteenth and early twentieth centuries through the use of barranca canalization and maguey bancals by the haciendas. Since the appropriation of the haciendas these reclaimed areas have undergone erosion. This was a result of a lack of interest on the part of the campesinos in extensive cultivation of maguey. They directed their interests toward the rich flat lands of the haciendas letting the hillsides erode.

> As the seventeenth and eighteenth century erosion progressed, only terrace systems located near villages managed to survive. Well-maintained terrace systems occur today at Belen, Tolman, Santiago Tepetitlan, and Oxtotipac, within the valley, and also on the northern slopes of Cerro Gordo. Generally terrace systems in relatively isolated parts of the valley tend to be better preserved and more thoroughly utilized than those in the Lower Valley. Such communities are more dependent on agriculture than those lower down where the urban labor market absorbs a growing proportion of the peasant population into non-agricultural activities. Ambitious attempts at land reclamation on slopes are most commonly found in the more isolated areas. Apparently when recent population growth produces pressures, the more isolated communities respond by building terrace systems; where facilities for commuting to the city are available, the population responds by working part or full-time in the city. (Sanders 1965: 40).

Bancal Terracing

Bancal terracing refers to terracing of a type which involves the use of maguey and low earth banks only as soil conservation mechanisms. Maguey planted on low earth banks are frequently found in areas of gentle slopes to retain soil and prevent erosion. Sanders noted this both for the Middle Valley (1957: 127) and the northern slope of Cerro Gordo (1964a: 6). These low bancals occur in areas of the valley where the gradient necessitates the presence of some technique to prevent soil erosion. The terracing previously described represents an adaptation of this technique to conserve soil in eroded areas, particularly on more steeply sloping terrain.

Sanders (1963: 13) also applies the term bancal terracing to the practice of planting parallel rows of maguey on medium to steep slopes a meter or two apart without any structure between them. This not only prevents the loss of soil present but acutally results in an increase in the soil cover between the rows of magueyes (usually planted 6 - 8 m apart). According to Gamio (1922 T. II: 108) the land between the two rows of magueys was called metepantle. He stated that after five years it was possible to plant barley on the metepantles. This term is not common in the Teotihuacan Valley today although it is still used in the Apan Basin.

Many of the severely eroded slopes in the Teotihuacan Valley are the result of a failure to maintain the hacienda metepantles after the agrarian reforms. The campesinos preferred the lower, flatter areas.

Bancal terracing has agricultural significance in the Teotihuacan Valley for two reasons. First, it prevents erosion in fields which are so situated as to be subject to erosion. In this way it acts as an effective maintenance mechanism. Second, bancal terracing as used by the haciendas and by some campesinos today brings into use a large percentage of that area of the valley which is marginal agricultural land because of severe erosion and a thin soil cover which cannot adequately store the insufficient rainfall. Undoubtedly this type of terracing is Prehispanic in origin.

5. Presas

In this paper presas refer to check dams built within barrancas for the express purpose of trapping eroding soil (lama) to form agricultural land. They represent another response to the problem of soil erosion in slope area. When such a dam is constructed the accumulation of silt behind it forms a fertile field which has great moisture retention capacities.

Presas occur throughout the valley, both as a result of intentional construction, and as a result of failure to clean diversionary dams in floodwater irrigation systems. The most elaborately developed presas systems of the area are found on the northern slope of Cerro Gordo in association with the terrace systems of Maquixco el Alto and Colhuacan.

Construction of presas today involves the building of a low stone wall (ca. 1 m high) across a barranca bed. The stones are piled dry and not embedded in earth mortar. It is essential to construct the base of the presa carefully or else the presa will have a tendency to wash out after a heavy rain. Each year the wall is increased in height during the dry season and the field behind it becomes deeper and spreads further up the barranca. Maguey and fruit trees are planted behind the wall to reinforce it and on large presas maguey bancals are found within the field to further control erosion. "Finally a wall 30-40 feet high may result and the entire barranca may be filled in with soil for distances of 30-50 m. upstream behind the wall." (Sanders 1965: 43).

Isolated presas tend to be unstable in the face of the strong erosive force of the water descending the barranca. To ensure stability presas are built in a series to support each other. Even in these series there is a tendency for the lowest presas to wash out. If they are not maintained and repaired the entire series may be destroyed in a few seasons.

Several barrancas on the northern slope of Cerro Gordo have been completely silted in through the construction of presas. The amount of time required for the accumulation of soil in a presa is variable and depends on the amount of water available, the width of the barranca and the presence or absence of other presas further upstream. One presa in the Maquixco Alto area, with a depth of 7 m, is reported to have been constructed over a period of twenty-nine years.

Organization of Presa Construction

Today presas are constructed by a few men working together during the dry season. These may be related, as in the case of a father and his sons working together, or they may be hired by the landholder. At least three to four men are needed to construct a small presa. In the past the haciendas employed many workmen to build presas and used true masonry construction. Some of these are still standing and are very large, larger than any of the more recently constructed presas of the campesinos.

Although there is no larger organization involved directly in the construction of presas there are some controls over the selection of locations for new presas. The barrancas which run through ejido lands are considered to be Vias Nacionales. Ejido holdings run only to the edges. It is necessary to obtain from the Comisario Ejidal a title before beginning construction. According to one informant this was to prevent disputes between individuals. The presa constructed in a barranca running through ejido lands is held only by the person who built it.

The situation in the case of private property is different. Private property boundaries are considered to run to the center of the barranca. Therefore, unless an individual owns both banks of the barranca, it is necessary to obtain the permission and cooperation of the owner of the land on the opposite bank before constructing a presa. He, of course, will share in one half of the resulting field. If the soil behind the dam backs up into the private property of other campesinos then that portion belongs to them. But they must help in the upkeep of the presa as they gain some benefit from it.

There are some examples of large presas constructed by the Hacienda San Cayetano that have been divided into individual ejido holdings for the campesinos of Maquixco Alto. In one of the large presas a wall has washed out causing considerable erosion in the field. All holdings are ultimately threatened and the lands are very good. However, no attempt has been made to organize a work force to rebuild the wall. According to one informant this would require hiring persons to do it and the amount of money needed could not be easily raised.

Agricultural Significance of Presas

According to informants in Maquixco Alto and Colhuacan the fields formed by presas are the best lands available for agriculture in the area. They are equalled in their productive capacity only by the highest terraces on the slopes of Cerro Gordo in the same region, and their production approaches that of the irrigated lands in the Lower Valley.

The significance of the presas for agriculture stems from the humidity retention capacity they possess and their ideal location for trapping both soil (at times referred to as "abono de Cerro Gordo") and water. Because of water retention ability and the ideal location to trap runoff from the hills, it is very rare that a crop is lost in the presas, even though they may be failing in areas immediately adjacent.

Special cultivation techniques similar to those used in the Middle Valley alluvial plain area are applied to conserve moisture in the presas during the

dry season. Maize is planted as early as February in some presas. Special planting techniques are also applied to the presas to make available subsoil moisture.

Maguey and fruit trees are frequently found on the edges of presas. Beans and squash are planted with maize, the dominant crop grown in the presas.

Elaborate presa systems are found in many of the barrancas of the northern slope of Cerro Gordo, including the systems of Colhuacan and Maquixco Alto and those of Santo Domingo, located slightly to the east. In addition large presas occur at Belen and San Antonio de las Palmas. Small presas occur in hillslope areas throughout the valley and silted presas designed for floodwater irrigation are frequently used for crops.

The system of the northern slope of Cerro Gordo appears to be relatively recent in construction.

6. Summary

Six techniques have been described that are used by farmers in the Teotihuacan Valley and adjacent areas to cope with problems that derive from the climatic and topographic characteristics of the environment. The application of each technique is associated with the subsequent formation of the soil types described earlier. These soil types in turn are the primary determinants of crop distribution and crop yield. In the following section information will be presented with respect to types of crops, their distribution, yield and use in the Teotihuacan Valley.

CROPS

The crops grown in the valley today are a mixture of aboriginal and Hispanic cultigens. The crop inventory is best viewed as aboriginal to which a number of European plants have been added, and from which a few native plants have been lost. The majority of the people living in the area today depend primarily on subsistence agriculture. For them the basic subsistence crop is maize, followed by beans and maguey. The major cash crop is barley. Other plants figure in both diet and market but are generally of less significance.

1. Maize

Maize is the staple food, not only in the Teotihuacan Valley, but throughout much of rural Mexico. Several varieties of maize are present in the valley and vary with respect to moisture requirements, yields and time necessary to reach maturity. The greater the amount of moisture required and the longer the period of time needed to reach maturity for a variety the greater the yield per hectare.

Sanders (1965: 32) mentions the existence of a "fast-maturing, low producing 'tres meseno', adapted for drier areas." This is also known as maiz chico or four month maize. Another variety (probably several varieties) which matures more slowly and with a higher yield is maiz grande or six month maize. In addition, maiz chalqueno is grown in the Lower Valley alluvial plain (Millon et al. 1962: 497). Maize also varies as to color. White and yellow corn are most frequently encountered but black corn also occurs. More botanical work should be conducted to determine more precisely the exact types of maize which are represented in the valley today.

Maize prefers soil which is deep and well-watered. Thus the heaviest concentration of maize is in the alluvial plains of the Delta, Lower and Middle Valleys. It also occurs in deep, well-watered terraces, most presas, and gentle slope areas with deep soil and effective erosion control. However, since maize is a staple crop it "is generally grown everywhere, even in areas where soil depth and moisture are inadequate. There is a tendency to extend maize cultivation to the limits of the capacity of the area in years when the rains begin early." (Sanders 1965: 32). Consequently, although the greatest concentration (and production) of maize is in deep soil, well-watered parts of the valley, it also occurs in fields with shallow soils, little control of erosion except for maguey bancals, and complete dependence on rainfall for moisture. The varieties with the lower yields and shorter growing seasons are found in these temporal lands and the other higher yielding varieties with longer growing seasons are planted in the deeper, moister soils of the valley.

Yields of maize vary considerably depending on the date of planting and the quality of the rainy season. In addition the particular planting and cultivation techniques (to be discussed later) affect the yield. Sanders (1957; 1965) has presented some data on maize yields in various sections of the valley and I have collected similar data from the northern slopes of Cerro Gordo. This data is summarized in Table 3.

Table 3

MAIZE YIELDS (PER HECTARE)

AREA	RANGE	AVERAGE OR MODE
Lower Valley (Permanent Irrigation)		
Atlatongo	900-2250 kg.	1500-2250 kg.
Calvario Acolman		1200-1500 kg.
Middle Valley (Floodwater Irrigation)		
San Pablo Isquitlan	900-1500 kg.	1200 kg.
San Martin	900-3000 kg.	1500-2250 kg.
Middle Valley (Temporal)		
San Pablo Isquitlan	600-900 kg.	
San Martin	450-2000 kg.	
Santa Maria Coatlan	450-1800 kg.	600 kg.
San Francisco Mazapan	450-1800 kg.	600 kg.
Cerro Gordo-North Slope (Terrace, Presa humedad)		
San Cristobal	1500-2250 kg.	
Santa Maria Maquixco el Alto	1050-2250 kg.	Terrace avg. 1350 kg.
	1200-3000 kg.	Presa avg. 1800 kg.
Cerro Gordo-North Slope (Temporal)*		
San Cristobal Colhuacan	900-1500 kg.	1050-1200 kg.
Santa Maria Maquixco el Alto	900-1500 kg.	1050-1200 kg.

Note: Data from Sanders 1957 and fieldnotes taken by the author in 1964.

* Average yields for temporal lands include only years in which some crops were harvested and omit years of total crop loss.

It is obvious from the data in Table 3 that there is a significant difference in the productivity of deep moist soils and those which are shallower and depend on rainfall.

The residents of the valley consume most of the maize produced there, usually in the form of tortillas. Some maize is sold. The cobs are dried and stored either in the house or in a corn crib. The kernels are removed during the dry season when agricultural activity is lessened. Seed for the next year's planting is always set aside from the harvest.

2. Wheat and Barley

According to Gamio (1922, T. II: 111) the type of wheat grown in the valley was Triticum vulgare, Villars. At the time of his study wheat was not a very important crop. Since wheat was grown during the winter irrigation was necessary. Consequently only the haciendas of Santa Catarina and San Jose grew it to any extent.

Sanders has pointed out that wheat requires similar soil conditions to maize, relatively deep soils with abundant moisture (1965: 32). As a result it is grown in the same areas as maize but in much smaller amounts. In the Lower Valley it is planted as an irrigated dry season crop. The Lower Valley alluvial plain and the Delta area produce most of the wheat in the valley. In other parts of the valley wheat occasionally is planted during the summer rainy season.

As with maize the yields are related to soil depth and available moisture. Table 4 summarizes the available data on wheat yields.

Table 4

WHEAT YIELDS

AREA	AVERAGE PER HECTARE
Lower Valley (Permanent Irrigation)	
Atlatongo	1800 kg.
Calvario Acolman	1000-1200 kg.
Cerro Gordo-North Slope (Temporal)	
Santa Maria Maquixco el Alto	450 kg.

Note: Data from Sanders (1957: 144, 147) and Charlton fieldnotes.

Average yields for temporal lands include only years in which some crops were harvested and omit years of total crop loss.

Wheat is planted primarily for export. Some use is made of it locally in a beverage or gruel known locally as atole. Since maize and wheat require the same soil conditions they may be considered as competitors. Due to a conservatism in food preferences and a limited amount of suitable soil available wheat has not become established as a major crop in this area.

In contrast to wheat, barley has become an important crop in the Teotihuacan Valley. They type of barley present was identified as Hordeum vulgare, Linn. (Gamio 1922, T. II:111). Gamio further mentioned that barley ranked next to maize in terms of amount of seeded lands. Both the haciendas and the villages planted barley.

Barley requires less moisture and less soil depth than either maize or wheat. In addition it ripens sooner than both. Wheat requires six to seven months to mature, barley only four to five months. According to some informants barley requires less soil and moisture than do beans.

Because of its requirements barley tends to be found primarily in the Upper Valley and on hillslopes. Sanders has suggested that "In a general sense barley tends to replace maize up-valley and upslope." (1965: 32). It is possible that

barley has replaced beans in some areas. This suggestions, based on the similarity of ecological niches which they occupy, is further strengthened by statements from informants which indicate that there are some differences of opinion among campesinos as to the wisdom or value in planting one crop in preference to the other. Barley is seen as a crop which requires a large expenditure of time and money in harvesting while beans require less work and expense. It should be noted that barley is also planted in areas of deep soil and permanent or flood-water irrigation.

I have summarized data on barley yields in Table 5.

Table 5

BARLEY YIELDS

AREA	RANGE PER HECTARE	AVERAGE PER HECTARE
Lower Valley (Permanent Irrigation)		
Atlatongo	1200-1600 kg.	
Calvario Acolman	no data	
Middle Valley (Temporal)		
San Pablo Isquitlan	450-1500 kg.	500-600 kg.
San Francisco Mazapan	450-1800 kg.	600 kg.
Cerro Gordo-North Slope (Temporal)		
San Cristobal Colhuacan	750-1500 kg.	

Note: Data from Sanders (1957) and fieldnotes taken by the author in 1964.

Average yields for temporal lands include only years in which some crops were harvested and omit years of total crop loss.

Barley is undoubtedly the most important cash crop in the Teotihuacan Valley area today. Some barley is stored as fodder for horses, mules and burros when they are working in the fields. At other times they are fed zacate or straw. The economic significance of barley cultivation is outlined in a later section of this paper.

The expansion of barley cultivation in the area is probably due to the fact that its ecological niche complements rather than competes with that used by maize. Barley is considered a cash crop fit for consumption only by animals. It has not been incorporated into the diet of the campesinos.

3. Minor Field Crops

Beans

Gamio (1922, T. II:111) has identified the local beans as Phaeseolus

vulgaris lunatus, Linn. Then, as now, beans were planted primarily in hillslope areas, alone or with maize. Two varieties of white beans were cultivated by the village of Santa Catarina. Sanders has noted that today beans are an important secondary crop in the Lower Valley alluvial plain.

There exist several varieties of beans in the valley (negro, bayo and amarillo) (Sanders 1958: 143) which should be studied to clarify their significance. Beans and barley occupy similar ecological niches, both needing little moisture or soil depth. They are therefore competing plants. It is probable that beans have declined in importance in response to the increase of significance of barley since the Conquest. Beans are frequently planted with maize although they also occur alone. They require four to five months to mature.

There are some data available on the productivity of beans per hectare. Sanders (1957: 132) has reported a yield of twenty-five kilograms per hectare in land of the Middle Valley alluvial plain. This is a very low figure and is doubtless due to the small quantity of beans sown by the particular farmer, one kilogram per hectare. In the same area another farmer planted eight kilograms of beans per hectare and harvested four hundred and fifty to seven hundred and fifty kilograms of beans per hectare (Sanders 1957: 137). Although I have no figures on the amount planted, the harvests of beans in the area on the northern slope of Cerro Gordo suggest similar quantities for tierra de humedad. One hectare of good land will produce seventy-five kilograms of beans in a poor year and three hundred kilograms in a good year.

Beans are consumed as an important source of protein in a diet which includes very little animal protein. Some beans are sold as cash crops and some villagers plant little or no beans, purchasing them from the market instead. The growing and selling of beans is a highly individualistic matter depending both on the campesino and on the area in which he farms. According to one informant in Maquixco Alto beans are second only to barley as a source of cash income. In the neighboring town of San Cristobal Colhuacan another campesino stated that beans were rarely planted and that most persons purchased them from the market.

Haba Beans

The haba bean is an Old World domesticate which was introduced into this area by the Spaniards soon after the Conquest. There are accounts of the haba bean in documents of the late sixteenth century. Gamio (1922, T. II:111) has identified the haba bean of the area as Vicia faba, Linn. He noted that it was planted in terrenos de jugo with maize, in temporal lands or even as a winter crop in irrigated lands. It was of some significance because of its frost resistant capacity.

Today the haba bean occurs sporadically throughout the valley in the same types of land. There are no data available on the per hectare yield of the haba or on its exact place in the diet of the local population. It appears to play a very minor role both in diet and in economic importance.

Squash

Although an aboriginal crop the squash is of minor importance in the area today. Squash requires a growing season of five to six months and deep humid

soil. In such soils squash and maize are usually interplanted. In the Middle Valley squash are planted in the best lands of the floodwater irrigated alluvial plain (Sanders 1957: 132). Squash also occurs as an important secondary crop in the permanently irrigated alluvial plain of the Lower Valley (Sanders 1957: 143). The preferred locations for squash on the northern slope of Cerro Gordo are the deep soil presas and terraces which have an abundance of water.

Although there are no data available on yields it is apparent that squash do not form a major part of crop production in the area today. They are, however, an important supplement to the diet and during the fall it is possible to see them drying on house roofs, prior to winter storage.

All of the crops described above, wheat, barley, haba beans, beans and squash may frequently be found interplanted with maize in very fertile soils. All or only a few may be present, depending on the soils and the inclinations of the campesino.

Peas

Gamio identified the peas of the Teotihuacan Valley as Pisum sativum, Linn. (1922, T. II: 112). At the time of his study the cultivation of peas was concentrated in hillslope lands of small farmers. The harvest was very small.

Sanders (1957: 143) has indicated that peas are another important secondary crop of the permanently irrigated Lower Valley alluvial plain. Peas occur very sporadically throughout the valley and do not appear to be of great importance in the economy or the local diet. No data on yields are available. The pea, of course, is an Old World domesticate.

Lentils

Gamio (1922, T. II: 112) has a very brief entry referring to Lens escuelenta, Moench, which was cultivated in the valley on a very small scale similar to the cultivation of haba beans and peas. Today the plant is still present but of little dietary or economic importance. Data on distribution and yields are not available.

Alfalfa

In the study carried out by Gamio and his co-workers the alfalfa present in the valley was identified as Medicago sativa, Linn. (1962, T. II:112). At that time alfalfa was not extensively cultivated in the valley and occurred on the lands of the haciendas Cadena and Santa Catarina, the lands of the villa of San Juan Teotihuacan and lands near the Teotihuacan railroad station.

Alfalfa needs abundant moisture and deep soils. It occurs today in areas with permanent irrigation such as the Lower Valley alluvial plain and the Hacienda Hueyapan. With the increase in dairy cattle in the Lower Valley more hectares of alfalfa have been planted. Sanders has suggested that:

> In the Lower Valley and lake shore plain sections the economy is in a transitional stage between subsistence grain agriculture and dairy farming. With the increase in the urban market at Mexico City it

> seems certain that within a few years these sections will be completely converted over to commercial dairy farming. (1957: 111)

In this area alfalfa is the third most important crop after maize and barley. It is planted as a winter crop in a maize-wheat-barley-alfalfa cycle (Sanders 1957: 128). Both barley and alfalfa are less sensitive to drought than maize (Sanders 1957: 145).

Alfalfa is the chief crop of Calvario Acolman, followed by barley, wheat and maize. Sanders suggests that in recent years there has been a shift from a "grain-subsistence economy to an alfalfa-barley-dairy economy" (1957: 145) in Calvario Acolman and villages further down the Lower Vallley alluvial plain. This has resulted in part from the decreased supply of water in the irrigation system and parallels a process similar to that found in many of the villages on the Texcoco Plain (1957: 146). Alfalfa is rotated with other crops (1957: 146).

According to Sanchez Colin alfalfa in the Acolman area may be harvested at intervals of 25 to 30 days from June to October, and at intervals of 35 to 45 days from November to May (1951: 513). There is a minimum of eight harvests a year which produce from 10,000 to 12,000 kilograms of alfalfa per hectare each harvest. It is, however, necessary to irrigate the land after each harvest if cropping is to be continuous. With the permanent irrigation system in the Lower Valley restricting each farmer to three floodings a year it appears that constant cropping is impossible in this area. However, he goes on to state that the observed period of such continuous cropping in the Acolman area is from four to five years (1951: 514). I have heard similar comments from local campesinos. The subject of alfalfa cultivation in this area needs further study.

In addition to the cultivation of alfalfa in the Lower Valley alluvial plain other localized irrigation systems based on wells are used to grow alfalfa. Such systems are found at the Rancho La Ventilla, The Rancho Azteca, and the Hacienda Hueyapan. Others also exist and are usually tied in with the dairy cattle complex. The campesinos who own the Hacienda Hueyapan are selling the alfalfa to help pay off the loan needed for the purchase.

Vegetables (Hortalizas)

Although the valley is mainly a producer of grains a number of other crops are grown and consumed in the area. Among these are a number of vegetables which are mostly European in origin. Gamio (1922, T. II: 112) lists onions, beets, carrots, lettuce and cabbages as being of importance in the chinampa area of San Juan Teotihuacan. Sanders mentions the former cultivation of similar crops on chinampas at Atlatongo which are now used to grow fruit trees. (1957: 143).

Today the growing of these vegetables in the valley is restricted to the chinampas at San Juan Teotihuacan and the surrounding barrios of Puxtla and Maquixco. Residents of San Juan and Mexico City consume most of the vegetables (Sanders 1965: 45). There are no data available concerning yields. These vegetables provide a cash income.

Potatoes

Gamio reports that previously good harvests of potatoes (Solanum tuberosum, Linn.) were obtained from lands on top of Cerro Gordo. I heard the same statement from informants from Maquixco Alto and Colhuacan. No potatoes are grown there today and apparently none were grown there at the time of Gamio's study (1922, T. II: 107).

Some potatoes are grown in the area today but they are far from being an important crop. At Maquixco Alto and Colhuacan the practice is to plant a few potatoes in a presa while sowing maize. Potatoes are sold in the market in San Juan Teotihuacan and presumably they are grown in other areas of the valley, too. Unfortunately there is no information available on the distribution or the yield of potatoes in the Teotihuacan Valley. They are a minor cash crop and a minor addition to the diet.

4. Fruit Trees

Gamio has listed a number of fruits which were of little economic significance at the time of his study. They include pears (Pyrus comunis, Linn.), apples (Pyrus malus, Linn.), walnuts (Juglans regia, Linn.), grapes (Vitis vinifera, Linn.), tejocotes* (Crataegus mexicana, Linn.) apricots (Prunus armeniaca, Linn.), figs (Ficus carica, Linn.), pomegranates (Punica granatum, Linn.) and zapotes* (Casimiroa edulis. Llav. y Linn.) (1922, T. II: 112). These were grown in gardens on house lots.

Sanders (1957: 112) adds the following fruits to the above list: peach, plum and capulin* (a native cherry Prunus serotina capuli). All those marked with an asterisk are aboriginal domesticates. On the basis of his fieldwork of 1953 Sanders concluded that:

> Fruit cultivation other than nopal is of little importance. Most of the farmers possess no fruit trees at all; a few have a few trees of apple, peach, plum, apricot, pear, tejocote, zapote blanco, pomegranate, date and capulin. The largest orchard seen comprised but a few dozen trees and that was exceptional. The only one of some importance is the capulin, especially found along irrigation canals and barrancas. The others are almost entirely planted in houselots. (1957: 112)

He has restated this position in a later publication (1965: 45). This is in substantial agreement with Gamio's position of 1922.

However, there is some evidence to indicate that fruit growing is an expanding economic interest in the valley. I refer specifically to the village of San Pablo Isquitlan where in 1964 one orchard had at least one hundred trees of several varieties (capulin, pear, apple, apricot, and peach). The owner consumed some of his crop and sold the rest in Mexico City and Ciudad Sahagun. The trees are located in fields of the floodwater irrigated alluvial plain of the Middle Valley. They are interplanted with grains.

On the northern slope of Cerro Gordo in the village of Santa Maria Maquixco el Alto and San Cristobal Colhuacan there are small fruit tree orchards planted

with grain crops in deep humid soils, such as terraces and presas. They include apple, peach, capulin and apricot trees. The orchards are of only minor economic and dietary significance in the villages but they have some historical interest. Maquixco is mentioned in the 1580 Report on Tepexpan as growing "a quantity of pear, peach and quince trees which give fruit at Christmas." (Nuttall 1926: 78).

Sanders has also mentioned that at Atlatongo "house lot chinampas have been converted to fruit orchards including such trees as apple, peach, cherry, apricot, pear, pomegranate and fig." (1957: 143). The trees are planted in areas of moist, deep soils. No data on their yields are available.

Thus for the majority of the campesinos of the Teotihuacan Valley fruit trees are of very little importance for their diet or their income. However, there is some evidence which suggests that a few are becoming more oriented to the use of fruit trees as a cash crop.

5. Maguey

The maguey (Agave spp.) is an indigenous xerophytic cultivate of the Teotihuacan Valley. It is a plant with a great tolerance of thin soil and scarcity of water. The campesinos recognize at least four varieties of maguey. No botanical analysis of these has been reported.

The maguey is planted in all areas of the valley. Because of its ability to withstand unfavorable conditions it is an ideal plant to grow in areas of thin soil and low moisture. It even occurs on eroded tepetate slopes.

> In the Lower Valley it occurs in the piedmont, where it is planted around agricultural fields, on gentle slopes where it plays a dual role of erosion control and food, being planted in parallel rows and occurring even on the steepest and stoniest slopes. In the Middle Valley nearly all agricultural fields have maguey growing around them, even in the flat plains, and in the Upper Valley it is nearly the only crop in the dry thin soil piedmont that surrounds the Otumba plain. Nearly all the Upper Valley and much of the slope and piedmont lands of the Lower and Middle Valley would be agriculturally inproductive land without this plant. (Sanders 1963: 12)

In the area on the northern slope of Cerro Gordo maguey is planted as reinforcement for presas and terraces, as well as in rows within fields and on steep hillslopes. Magueyes are also planted in close rows in houselots within and on the peripheries of towns and villages.

I have previously discussed the role of maguey in erosion control and soil conservation efforts. In the pre-Conquest period the maguey fulfilled many functions. It provided pulque, a mildly alcoholic beverage made from the fermented sap (aguamiel). The aguamiel also provided a sweet drink by itself or vinegar if fermentation were carried on too far. Fibers from the pencas or leaves were used for cordage and clothing. The spines from the ends of pencas became awls, needles, and instruments for mortifying the flesh. At times the whole penca with its many small spines along the edges would be used by an

individual to whip himself as ceremonial penance. The juice of the pencas was prepared in several ways and used as medicine. Dried pencas were incorporated into houses as roofing materials or burned as fuel. The roots were roasted and eaten or used to make sugar. (Dibble and Anderson 1963: 179, 216-218; Peterson 1959: 169; Vaillant 1966: 141).

Gibson (1964: 7) has suggested that with the Conquest the status of the maguey changed in the Basin of Mexico.

> Under the stress of Spanish occupation and with the lessening of Aztec restrictions, a reduced population depended increasingly on pulque to help allay the rigors of Spanish exploitation. Supported by two changed conditions, one cultural and the other geographical, maguey came to be grown in areas that had once been more fertile and had supported much larger populations. (1964: 7).

Gibson documents the increase in the importance of maguey cultivation for pulque production during the Colonial Period (1964: 317-319). In the Teotihuacan Valley this emphasis continued into the nineteenth and twentieth centuries with the growth of the haciendas.

Gamio listed the following haciendas and ranchos of the Middle and Lower Valley that emphasized the growing of maguey for pulque production: Tenextlacotla, Bella Vista and San Jose Acolman (each with six hundred hectares under maguey cultivation), the haciendas of Tlajinga, Cadena, Cerro Gordo, Metepec, and Santa Catarina and the rancho of Oztoyahualco with the major portion of their lands dedicated to maguey (1922, T. II: 108, 456). In addition maguey cultivation and pulque production was also emphasized in the Upper Valley and on the northern slope of Cerro Gordo by several other haciendas and ranchos (Sanders 1965: 45).

At the time of Gamio's study only the haciendas and ranchos with large holdings exploited maguey extensively. The small land owners made little use of maguey compared to the haciendas. Today the situation has changed as a result of the agrarian reforms. The small remaining haciendas and ranchos continue to produce pulque. However, this is now an important cash crop for the peasants. It still forms a significant part of his diet. "As a food pulque contains a variety of minerals and vitamins otherwise lacking in the diet and has the added advantage that it can be produced throughout the year." (Sanders 1965: 45).

In addition to its use as a diet supplement the maguey has a number of other contemporary applications.

> Post-Hispanic uses would include fodder for domestic animals, planting drills, and wrappings for barbecued and steamed meat dishes. The pencas or leaves have a variety of casual uses, e.g., drinking and eating utensils, rollers and ramps. Its use as fuel is extremely important. . . .(Sanders 1965: 45)

A maguey plant needs between eight to ten years of growth before it is ready for pulque production. According to an informant from Santa Maria Maquixco el Alto the four types of maguey and their yields are as follows: maguey ayoteco,

produces six liters of aguamiel twice a day for a period of three months; maguey carrizo, produces four liters of aguamiel twice daily for a period of three months; maguey manso, produces three liters twice daily for a period of three months; maguey cimarron, produces two liters a day for one month.

Once a plant ceases to produce aguamiel it dies and the dried pencas are used for fuel and roofing. It is then necessary to replace the plant with another. These may be young plants which appear as shoots from mature plants owned by the cultivator (maguey appears to propagate by runners) or they may be purchased. The cost varies according to the productive ability of the plant, a manso selling at ten pesos, the same price as a carrizo; an ayoteco selling for fifteen pesos, and a cimarron for three and one-half pesos. The new plant consists of three pencas and the root. It is usually planted in July or August during a break in the rainy season.

Some campesinos rasp only enough magueyes to supply pulque for their own tables. Since it takes some time for a plant to mature an individual must have between sixteen and forty plants in various stages of growth to ensure a daily supply of aguamiel. Once the aguamiel is collected it is taken to the house in wooden barrels by burro and emptied into larger containers. These containers have some fermented aguamiel present to initiate the fermentation process.

A campesino may sell his excess aguamiel to a tinacal in his village or he may sell his mature magueys, to the tinacal or to other interested individuals, or he may market it himself. The villages of Santa Maria Maquixco el Alto and San Cristobal Colhuacan, produce a surplus supply of pulque. This is sold to communities on the lake shore and to Mexico City. This trade appears to be quite old and is possibly pre-Conquest in origin. Communities in the Middle and Upper Valley sell pulque to Mexico City. This is usually transported by railroad and large barrels may frequently be seen standing in the Otumba station.

Although pulque is produced in all parts of the valley the slope and hill areas of the Middle, and Upper Valley, and the North Slope of Cerro Gordo are the major centers of production.

In Gamio's report on the Teotihuacan Valley some suggestions were made concerning improvements in the production of pulque and the introduction of new uses for maguey. In the summer of 1964 a new building was completed between Otumba and Axapusco. It was called "El Patronato del Maguey" and was a project of the Federal Government designed to develop the economy of the Upper Valley area through the introduction of new pulque production facilities and new uses for the maguey plant. It was inaugurated in September 1964, by the outgoing President, A. Lopez Mateos. In the summer of 1966, upon my return to this area I expected that the Patronato would be well underway. It was virtually abandoned. I could discover no official explanation although there are many unofficial theories. They include the suggestions that pulque cannot be made without the traditional vats, that the campesinos refused to sell either plants or aguamiel to the Patronato, and that the incoming President G. Diaz Ordaz refused to support the project. Nevertheless the production of pulque continues as a major factor in the economy of the valley, particularly those parts of the valley which have thin soils and light rainfall.

6. Nopal

This cactus (Opuntia Spp.), like the maguey, is an indigenous xerophytic cultivate of the Teotihuacan Valley. It has the same ecological tolerance as the maguey and grows both wild and as a domesticate. There are several types of nopal recognized by the local campesinos. These are usually differentiated on the basis of the color of their fruit, the tuna. Light green tunas are referred to as blanco (white) and dark red tunas are called colorado (red). The wild tunas in the area are usually the red variety. The variety which produces tunas blancas does so in the late summer and early fall. The other variety produces fruit all year. (Sanders 1965: 45).

A major area of nopal cultivation is within the area of the ancient city of Teotihuacan, the tlatel zone of the Middle Valley. In "the villages of San Martin de las Piramides, San Francisco Mazapan and Santa Maria Coatlan, nopal orchard cultivation is an important item in the family economy, providing a cash income. These villages supply a substantial percentage of the nopal market of Mexico City." (Sanders 1957: 111).

In addition to this area nopal is cultivated in houselots throughout the valley. However, their commercial importance is greatest among the villages located on the eastern portion of the archaeological zone. The village of Maquixco el Alto sells some tunas to markets in Mexico City as do other communities in that area, but the quantity produced is much less than that of the Middle Valley.

In addition to the tuna, young nopal leaves are also used for food. They are cooked as a green vegetable.

> Generally, nopal is a houselot orchard crop, but occasionally outlying fields are planted entirely in this crop. At times it is planted along terraces instead of maguey. Young plants are imbedded in excavated pits, frequently in areas of exposed tepetate, to provide extra moisture even though the nopal has great drought resistance abilities. (Sanders 1965: 45).

The tuna is of importance both for its place as a cash crop in the economy of the valley, and for its contribution of sugar to the diet. Undoubtedly this was of more significance in the pre-Conquest period.

7. Summary

In the preceding section some of the major crops currently grown in the Teotihuacan Valley have been discussed. Their present distribution and emphasis results from the operation of complicated ecological and historical factors. I have briefly discussed both sets of factors in their application to modern crops.

With two major exceptions crop distribution and emphasis in the valley today closely approximate the situation described by Gamio in 1922 (1922, T. II: 107). One exception is the increase in alfalfa cultivation and dairy farming in the Lower Valley alluvial plain. The other is the gradually increasing emphasis on fruit trees as cash crops. Both changes are due to the developing urban markets, especially in Mexico City.

TECHNIQUES OF CULTIVATION

Under Techniques of Cultivation are included, not only those immediately involved in planting, cultivating and harvesting, but also some which are used to maintain soil fertility and humidity. Techniques of land cultivation before and after planting vary according to the type of crop and the nature of the soil (Gamio 1922, T. II: 454; Sanders 1957: 125). All of these are associated with post-Conquest implements and it is probably correct to suggest that few pre-Conquest cultivation techniques of any importance survive in the Teotihuacan Valley today.

1. Tools

The agriculture of the campesinos of the Teotihuacan Valley is plow-based. When Gamio made his study between 1917 and 1922 the plow used was the arado criollo (1922 T. II: 454), a variant of the arado dental described by Foster (1960: 52). This plow type has been replaced by the steel plow which is now widely used through the valley. Lewis (1951: 133) records a similar change in plow types in the village of Tepoztlan between 1920 and 1943.

Horses, mules, burros and oxen are used by the campesinos to pull the plow. A variety of hitches are used. Oxen are yoked by the horns. Hitches between the plow and a wooden saddle or a collar are preferred for horses, mules and burros. Today there are very few oxen used as draft animals in the valley. According to some informants, however, they were very common before the agrarian reforms. Within the last twenty years horses, mules and occasionally burros have replaced them.

Some tractors are now used and owned by a very few campesinos. In San Pablo Isquitlan there are three farmers who own and use tractors. Reports from San Cristobal Colhuacan and Santa Maria Maquixco el Alto indicate that tractors may be rented from Temascalapa if desired. They are used with disc plows to work the land. According to Casanova Alvarez (1966) the individuals who introduce new agricultural machinery to their rural communities are members of rural elites. It is quite apparent that their economic status is high within their own community. The greatest use of tractors for plowing occurs in areas with relatively large and flat fields, such as the Middle Valley. In many other parts of the valley tractors are impractical for land preparation and cultivation because of the difficult terrain and the very small size of the land holdings.

Tractors are used not only for preparing and cultivating the land but also to run threshing machines, especially for barley. One individual, from Venta de Carpio, owns a John Deere tractor designed to run on keros ne, and a McCormick-Deering No. 3 threshing machine. He rents their services to villages within the valley and on the northern slopes of Cerro Gordo. The tractor provides the motive power via a belt linking a large drum on the motor to a wheel on the threshing machine.

With the exception of the rapid spread of the steel plow and the occasional occurrence of other agricultural machinery such as tractors, threshing machines, simple balers working with horse power and some motorized cultivators and mowers

for alfalfa, the technology of the campesinos remains relatively simple. The existing haciendas and ranchos still make great use of modern agricultural technology in their activities. The situation remains similar to that described in Gamio's report.

> Actualmente, a excepcion de las haciendas que poseen arados de vertedera y disco, polirrejas Sack, rastras de dientes, sembradoras de maiz, cultivadoras Planet jr., desgranadoras, trilladoras movidas por vapor y una que otra aventadora de granos, el pequeno agricultor solo posee un arado egipcio (de madera o del pais), una viga y una rastra de espinos que con facilidad se improvisa. (1922, T. II: 114)

In addition to the major tools noted above the sickle is widely used for harvesting barley, wheat, alfalfa and clover.

2. Land Preparation

Before planting a field the campesino carries out a variety of land preparation techniques. The exact number, the frequency with which they are practiced and the intensity of application vary both with the type of land involved and with the crop to be planted. The most elaborate complex of land preparation techniques is associated with the preparation of tierra de humedad for maize. Given the climate of the valley and the dietary significance of maize this is to be expected.

In the following sections each technique shall be described, its agricultural significance assessed and, its distribution within the valley and adjacent areas explained.

Barbecho

The barbecho is the initial step in preparing the land after the crop has been harvested. It consists of a very deep plowing of the field lengthwise. The plow is run through, and occasionally between, the rows of maize hills left over from the previous season. (Sanders 1957: 123). "The main function is to loosen the soil to permit capillary action between the upper and lower soil levels and to allow the humidity to pass downward." (Sanders 1957: 123).

In the tierra de humedad of the Middle Valley the barbecho is completed in November or December, often following a thorough irrigation of the land after harvesting. It is followed by the rastreo immediately and the cruzada two months later in January or February. According to Sanders it requires one team three to four days to barbechar one hectare (1957: 123).

Farmers working the irrigated lands of the Lower Valley follow a similar procedure in preparing the land although some give only the fall barbecho, relying more heavily on the regularity of the permanent irrigation system (Sanders 1957: 124).

Similar procedures are followed on the presas and terraces of San Cristobal Colhuacan and Santa Maria Maquixco el Alto on the northern slope of Cerro Gordo. The tierras de humedad to be planted in maize are prepared early in

January, usually after one or two days of heavy rain. The barbecho is applied, followed immediately by the cruzada and rastreo, in that order. No further work is carried out until planting.

Some campesinos of the Teotihuacan Valley and adjacent areas also give a barbecho to tierras de temporal that are to be planted in maize. This is done in the late fall or early part of the following year. Only the barbecho is used and not all farmers apply it to their tierras de temporal (Sanders 1957: 124)

Rastreo

The rastreo involves dragging a log or timber (rastrillo) behind a team of horses to smooth down the furrows of the barbecho or cruzada. This seals off the soil to prevent moisture evaporation (Sanders 1957: 123).

In the Middle Valley the rastreo follows immediately after the barbecho of the late fall and the cruzada early in the following year. The same practice occurs in the tierra de riego of the Lower Valley where the campesinos follow similar land preparation techniques. On the north slope of Cerro Gordo the rastreo is applied to tierras de humedad after both barbecho and cruzada have first been carried out. It is the third step of a sequence of land preparation and is practiced only once each year on the tierras de humedad. The sequence is obviously a variation on the sequence of land preparation found in the Middle and Lower Valleys.

Cruzada

According to Sanders (1957: 124) "This is a second plowing made across the field at right angles to the barbecho." Campesinos on the northern slope of Cerro Gordo also use the term in the same way. However, Gamio (1922, T. II: 455) uses the term raya to refer to this type of plowing, reserving the term cruce to mean diagonal plowing. Sanders (1957: 124) does mention diagonal plowing as a third plowing, applied after the cruzada and carried out by some farmers in the Middle Valley. However, he gives no term for it. Sanchez Colin (1951: 398) uses cruza to mean plowing at right angles to the furrows of the barbecho. Here I shall use the term as defined by Sanders.

In the Middle and Lower Valleys the cruzada is used in January or February after a rare winter rain (Sanders 1957: 124). The plowing is shallower than in the barbecho, is more closely done, and helps break up the soil more thoroughly. The time involved is the same as for the barbecho and the cruzada is followed by an immediate rastreo (Sanders 1957: 124).

The cruzada is applied on the northern slope of Cerro Gordo immediately after the barbecho and followed by the rastreo. Three days per hectare are needed for these three operations.

Taken together these humidity conservation techniques are important aspects of the agricultural systems of the Teotihuacan Valley. By preserving humidity they permit earlier planting and decrease crop loss through either drought or frosts.

They are quite obviously techniques imported from Spain (Foster 1960: 58). It is possible that there is a historic link between the floodwater irrigation

system of the Middle Valley and the highly elaborated humidity conservation techniques of Spain. Without them the land would not be as valuable or productive as it is today. The Middle Valley alluvial plain without floodwater irrigation would appear similar to the Upper Valley plain. The techniques are essential to the success of the system.

3. Sowing

Sowing techniques are most elaborate for maize, particularly when sown in tierra de humedad. This parallels the greater emphasis generally on soil preparation techniques for maize.

Surcado

The surcado consists of a final plowing of the land for sowing. There are several specialized techniques of sowing which are carried out with the surcado or after it has been completed (Sanchez Colin 1951: 398; Sanders 1957: 124). The surcado is applied to all types of land and is associated with all types of crops in the Teotihuacan Valley and surrounding area.

Broadcasting

Fields in which barley is planted receive only the surcado prior to sowing. Sowing is done using a broadcasting method after the surcado. Then a second plowing buries the seed.

Lands used for winter wheat in the Lower Valley are given the barbecho immediately after the maize harvests in September or October, and two weeks later the cruzada. Then they are irrigated and plowed for broadcast sowing. (Sanders 1957: 127).

Alfalfa is also sown using a broadcast method in lands which have received the surcado. At the Hacienda Hueyapan the fields are leveled, after sowing, by the rastreo. Then they are irrigated. The use of the rastreo for barley, instead of a second plowing, to bury seeds has also been noted for Maquixco Alto and Colhuacan.

A Cajete or A Todo Costo

The a cajete or a todo costo technique of sowing is carried out after the surcado has been given to the field.

> Then small pits were excavated by hand in the soft broken soil at .5-1.0 meter intervals down as far as the humid soil layer. This humid soil on well prepared lands lies normally at 20-30 cms. below the surface. In the Texcoco area a thin cap of the humid soil itself is removed, the seed imbedded in the humid soil, then covered up by the removed wet soil, and finally a 10 cm. cap of dry soil replaced over that. A slight hollow is usually left to further help in gathering humidity when the rains occur. In the Teotihuacan Valley the seed is simply embedded in the first humid soil encountered and then covered over by a cap of the upper dry soil. (Sanders 1957: 125).

This technique requires manpower and time. Estimates vary on the amount of time required but it appears that one man could plant a hectare of land in two to three weeks. Since the technique is so laborious and help is frequently needed to finish sowing a field in this way, many campesinos have adopted other methods to sow their tierras de humedad. They recognize the advantages of the a cajete system in giving maize an early start and protecting it against loss through frost or drought (sowing occurs between February and May) but claim that it has become too expensive to use.

The system is closely associated with tierras de humedad and tierras de riego, and with maize. Sanders (1965: 34) has pointed out that since 1950 the number of farmers using the a cajete method has decreased. In 1964 I noticed one example at San Pablo Isquitlan and two on the northern slope of Cerro Gordo. One case at Colhuacan involved an entire presa sown in this fashion. The other at Maquixco Alto was a special use of the system to sow maize a cajete only in the two rows along the front of the presa. This was done to give the plants an early start to help prevent erosion of the presa edge.

The al tubo technique is one which has replaced the a cajete technique for the sowing of maize on tierras de humedad and tierras de riego. It represents a less laborious way to reach the moist soil with the seed. The al tubo method of sowing may be used in conjunction with the surcado or after the surcado has been completed. At San Pablo Isquitlan in 1964, I observed a field being sown al tubo without first being given a surcado.

The plow used for al tubo sowing has a deeper excavating share. Attached to it is a tube. The tube may be made of two maguey pencas lashed together or may be a metal funnel with a very long attached cylinder.

> The farmer drops the seed into the cylinder as he manipulates the plow. The plow theoretically slices down to the humid subsoil, the seed rolls down the tube to this level and the soil falls back over the seed. Most farmers feel that the cajete system is more dependable (since the humidity level varies and in dry years the plow probably does not reach it) but the al tubo method is more economical. Only 30 man hours of work are needed to plant one hectare. (Sanders 1965: 35).

In contrast the cajete system requires between 80 and 160 man hours per hectare (Sanders 1965: 35).

The al tubo method may be used with only one man manipulating both plow and seeds or two men may work together, one on the plow, the other dropping the seeds.

This method of sowing is associated with the planting of maize (and beans, haba beans and squash when they are interplanted with maize) in tierras de humedad or tierras de riego. However, other methods are also used for the same lands and crops.

A Rabo de Buey

According to informants on the northern slope of Cerro Gordo presas and terraces may be sown a rabo de buey instead of a cajete or al tubo. This method

involves the use of two teams with plows, or one team with a plow and one with a beam to rastrear the field. The first team breaks the soil--in other words the surcado. This team is followed by a man who scatters the seeds. He is followed by a second team with either a plow or a heavy beam to inter the seed. According to informants both methods are used.

This method has the advantage of offering protection for the seed from drought for up to one month after planting (Sanchez Colin 1951: 399). Farmers in Colhuacan and Maquixco Alto state that in this system more seed is planted than in tapa a pie.

Pata a Pie or Tapa Pie

Another technique of planting is tapa pie. It involves the use of one team with a plow and one man who walks behind sowing the seeds. The team gives the surcado to the field. The person following with the seeds drops them into the furrow at about one meter intervals and steps on them to cover them. The soil used to cover the seeds comes from the edges of the furrow.

Sanders (1965: 39) associates this method with maize in tierras de temporal. However, it is also used in tierras de humedad on the northern slope of Cerro Gordo. The tierras de temporal are sown usually after the first heavy rain in May.

Pala y Pie

Pala y pie is a variant of this technique used on both temporal and humedad lands with maize and associated crops. It is also referred to as a piquete. It is similar to tapa pie but varies in details. Essentially the same procedure is used in opening the furrows. But the man following behind the plow opens small holes in the furrow with a shovel or a hoe and drops the seeds in, covering them with the instrument used.

This method is described by Gamio (1922, T. II: 455). It was used in tierras de humedad of San Pablo Isquitlan and Santiago Tolman in 1964. Informants on the northern slope of Cerro Gordo say that it occurs there too. It is possible that this method and tapa pie are derived from pre-Conquest sowing techniques using a coa.

4. Cultivation

Once the seeds are in the ground the campesino has further work to do. Wheat is irrigated 45-60 days after planting. Barley receives irrigation if water is available. Usually barley is sown in tierras de temporal and no work is done on it until harvest. For maize, however, there are a number of cultivation techniques applied between sowing and harvesting.

Escarda

When the maize has reached a height of twenty cm. (two - six weeks after planting) the farmer cultivates between the furrows. This process heaps soil on both sides of the plant thus establishing a firm base to protect them against wind and water damage. Often the soil reaches to within four or five cms. of

the tops of the plants. The escarda also helps retain the humidity of the soil. (Gamio 1922 T. II: 455; Sanchez Colin 1951: 400; Sanders 1957: 126). Weeds are also removed and their growth hence curbed by the same process.

The plow used for escarda and also for the segundar or segundar escarda makes use of an orejera of branches of trees tied on the plow to help pile up the soil on the side as it passes over the ground. Other men follow the plow to clear away earth which has fallen over the tops of the plants and to remove weeds. According to Sanders (1957: 126) the work of either escarda or segunda escarda "involves one team of animals and the labor of three men, and two days of work are needed to cultivate a hectare."

Segunda Escarda or Segundar

This is a repetition of the escarda and occurs two to four weeks later. Both escarda and segunda escarda are used with maize sown in tierras de riego, tierras de humedad and tierras de temporal. Other crops sown in the same fields such as beans are planted close to the maize plants and are thus subjected to the same techniques of cultivation.

Echar Monton

The custom of hilling or aterradero also occurs in the Teotihuacan Valley. It is not always used since the first two techniques described serve some of the functions of hilling. However, it a man has enough time and/or money he will hill his maize. This frequently requires the hiring of several individuals. It is done when the plant is well grown but before it has grown ears. Shovels are used in hilling and it "represents a ten-day job for one man per hectare." (Sanders 1957: 126).

Despunte

> "Some farmers also practice the 'despunte' or pinching off of the tip of the young ear. They claim that the despunte results in larger ears." (Sanders 1957: 126)

Irrigation

In the Lower Valley several irrigations may be given the maize after sowing. This also occurs in the Middle Valley but much less regularly.

5. Harvesting

The harvest date relates to the date of sowing. Maize sown in March will be ready in September. The harvesting of maize involves first cutting the ears from the stalks and later separating the dried grains of corn from the ears. The stalks are also cut down and carried to an era where they will be built into a zacate pile to be used as fodder during the dry season.

Barley is cut by hand, using sickles, and carried to the era. Here it is threshed. Today most farmers make use of the service of the threshing machine but some still use horses or other animals to trample the grain. It is then thrown into the air to separate the chaff from the seed. The barley is stored

in the house complex and most of it is sold. The straw is stacked at the era to be used as fodder.

Alfalfa is cut with a mower or by hand and either sold or stored as fodder. Wheat is treated in the same manner as barley.

No data are available on the harvesting of smaller crops such as beans, haba beans and peas. Undoubtedly these are picked by hand and shelled within the residential complex of the farmer.

6. Miscellaneous Techniques

Seed Selection

The selection of seed for sowing the following year is not consistent, although in the case of maize, the larger grains and ears are used. Enough seed will be set aside by each farmer for the amount of land he plans to use the following year.

Mixed Sowing

The sowing of two or more crops in the same field at the same time is a rather frequent occurrence in the Teotihuacan Valley and adjacent areas. The exact ratio of seeds used varies. Usually two to four maize seeds and one to two bean seeds are placed in the same spot. Others such as squash or haba beans may be added. At times barley,and less frequently wheat,is broadcast between the rows of maize (Sanders 1965: 35).

Fertilizers

In presas, terraces and fields with access to floodwater irrigation the lama or silt carried by the water is referred to as abono or fertilizer and does indeed help to maintain soil fertility. Other fertilizers include animal wastes, weeds and cornstalks.

> In general soil minerals are abundant and self-replacing; the main problem is humus maintenance. Animal fertilizers, especially from cattle and draft animals, are used although the supply is very limited due to the lack of domestic animals in general. Only a fraction of the lands can be fertilized and it is done but once every five or six years on the average. No case of the use of green fertilizer was noted, although weeds and cornstalks may be plowed under. Most animal fertilizers are allowed to rot two or three years before applying them to the fields. A few test fields studied indicate that for best results fields should receive fertilizer at least every three years. (Sanders 1957: 128)

Animal fertilizers are usually applied to the lands while they are under cultivation. The fields selected are maize fields which may be close to or some distance from the house where the fertilizer is stored. It is transported to the fields in trucks, if these are available, or more usually, on burros.

Natural refertilization of fields through soil deposited by floodwater irrigation occurs during the rainy season when the fields are under cultivation. Gamio (1922 T. II: 115-116) noted that the haciendas practiced a type

of floodwater fertilization in the permanently irrigated Lower Valley alluvial plain. When the winter wheat was harvested in June or July the fields were flooded with floodwater from the barrancas as a technique of fertilization. This system was known as enlame It is not formally used today although floodwater is added to the irrigation system when it is available.

Crop Rotation

Crop rotation is known and understood but not widely used in the area (Sanders 1957: 128).

> The reasons are obvious. Most farmers hold small holdings and their staple food, as in most of Mexico, is the maize tortilla. The first concern of the farmer is providing his family with maize for the year, and lack of land means he cannot rotate. In the Upper and Middle Valley maize is often rotated with barley and in the Lower Valley we find a maize-wheat-barley or -alfalfa cycle. (Sanders 1957: 128)

On the northern slopes of Cerro Gordo the same type of situation prevails, with little rotation being carried out. That which does occur is a barley-maize cycle, with three years of maize and two of barley. This occurs primarily on tierras de temporal since the best terraces and the presas are kept under constant maize cultivation.

It is possible that the practice of mixed cultivation of maize, beans, haba beans and squash in the better lands and occasionally in tierras de temporal functions as a technique of fertility conservation. (Sanders 1957: 129).

Intentional or planned fallowing is of slight importance in the area. Sanders reported no cases in 1953 in the Middle and Lower Valley, and I observed none in 1964 in the Middle Valley and on the northern slope of Cerro Gordo.

7 Organization of Labor for Cultivation

The situation for the campesinos remains quite similar to that described by Gamio (1922, T. II: 452-453). The landholder carries out the operations necessary in land preparation, sowing, cultivation and harvesting. In these he will be helped by members of his own family such as his sons and his brothers. He may acquire extra help,if this is needed,by hiring men or by arranging an exchange of labor with others. Both types of labor arrangements occur today.

Sowing and harvesting are the two major occasions when such additional help is needed. The farmer makes a cash payment to the owner of the threshing machine for the use of it. The payment is based on the number of bags threshed. However, he must make his own arrangements for labor needed in threshing. This usually involved a combination of exchange labor and hired help. If many campesinos within a community plan to use the threshing machine they may exchange labor and thus reduce their individual cash expenditures.

In most communities in the valley there exists no social institution above the family which holds land or which organizes labor for the cultivation

of fields. There are two exceptions. The first involves the use of water in the permanent irrigation system. The allocation of water is decided on by ejido holders in communities participating in the system, and consequently results in some direction of land working by determining the date of irrigation for various land holders. The second exception is the present organization of the Hacienda Hueyapan, owned and run by campesinos from San Pablo Isquitlan. All members of the Association are required to work on communal lands set aside to produce cash crops. The proceeds are used to pay back the purchase. Data is unavailable as to the selection of the president or the powers he possesses as head of the Association. Each member holds specific parcels of land that are considered as belonging to him and which he uses to support his family. Some lands are used as communal pastures.

8. Summary

In this discussion of cultivation techniques the treatment of deep and humid lands used for maize cultivation has been emphasized. It is obvious that the greatest elaboration of techniques has occurred in such lands. Both the ecological and the historical factors noted throughout the discussion help to account for the development of such an emphasis as well as explaining the corresponding lack of emphasis on techniques associated with other crops.

LAND TENURE AND USE

Today there exist in the Teotihuacan Valley two types of land tenure, pequena propiedad (private property) and ejido lands. In addition there are at present two systems of land rental, a medias or en aparceria (Nolasco Armas 1962: 68) and en arrendamiento (Nolasco Armas 1962: 70).

In the discussion which follows some discrepancies may be noted between data collected by Sanders (1957), Millon et al. (1962) and Charlton (1965). There are several reasons why such variations can occur. It is very difficult to obtain data on land tenure in the Teotihuacan Valley. This results from intentional deceit on the part of an informant or failure to describe land holdings completely. In addition errors can occur through a failure to understand fully the statements of the informants. Furthermore, the studies were carried out over a ten year period and changes in water rations, private land holdings, and ejido holdings undoubtedly have occurred through this period. In the case of water allotment in the Lower Valley permanent irrigation system the entire charter of the system was revised between the time of Sanders' study and that of Millon. Consequently the chart which Sanders copied from an official document at the junta represents 1954 regulations (Table 1 and 2). The changes in the charter might explain some of the discrepancies between data presented by Sanders and Millon et al. Sales of private lands and reassignments of ejidos might also account for other discrepancies in land tenure data. It should be noted that although differences do occur in the various studies they are quite minor and alter the picture of village economy very little.

1. Pequena Propiedad

There are two varieties of private property in the valley. One type is owned by ex-haciendas and ex-ranchos and consists of a remnant of their former holdings. The other variety of private property consists of lands held by members of communities in the valley, usually within the boundaries of an area of land referred to as the private property of the community. It is possible, however, for an individual to purchase and hold land in several different communities. The areas of private property of the various communities are former communal lands which were divided into private holdings during the nineteenth century. At this time many parcels were sold to the haciendas.

2. Ejido Lands

These are lands which the National Government restored or granted to communities after 1910 Revolution. This land may not be rented or sold. "Disposal rights reside in the ejido as a corporate group and ultimately in the national government." (Millon et al. 1962: 503). All communities in the valley have some ejido lands

3. A Medias or En Aparceria

This system of land use is one of the means of equalizing a situation in which land is unevenly distributed among all persons within a community. The person who owns or holds the land will allow another to use it for a season in exchange for one half the harvest. According to informants on the northern slope of Cerro Gordo the person using the land has to maintain it if it is tierra de humedad. Temporal lands do not have to be cared for.

The a medias system of land use is found in Colhuacan and Maquixco el Alto. It also accurs in other villages in the valley proper. It is preferred whenever there is some doubt about the certainty of a harvest.

4. Renting (En Arrendamiento)

The system of renting land requires a cash outlay by an individual for the use of the land of another. The rentee is not required to keep up the land nor does he have to turn over one half of the harvest.

Renting occurs in most communities of the valley. Both renting and a medias have been reported in San Pablo Isquitlan, Colhuacan and Maquixco el Alto. It is a preferred system in San Pablo since the harvest is considered dependable in the floodwater irrigated alluvial plain. The campesinos of San Pablo rent lands from farmers in San Martin. Very often these are lands that lie quite close to San Pablo but which are distant from San Martin.

Both renting and a medias act as mechanisms to allow persons with little or no land to make use of the lands of large landholders. Individuals with many hectares of land often find it difficult to work them intensively.

5. Summary

Although there are two systems of land tenure in the Teotihuacan Valley, private property and ejido, land is not evenly distributed within every community. This occurs in spite of the establishment of the ejido system to ensure lands for all. The two systems of a medias and renting, rectify to some extent the inequities of the tenure patterns.

The lands of each village, both ejido and private, are usually found within large, single tracts recognized as the lands of that village. It is possible, however, for a campesino to own private property within the private lands of another community, and to retain possession of his ejido lands even when he is no longer a resident of the community. The maps of land holdings of Maquixco Alto, Colhuacan, and San Pablo indicate the extent of private lands held by members of these communities within the area of private property of another community. Such a situation may develop in one of two ways. Campesinos moving from one community to another will retain possession of their private property. This has happened when families moved from Colhuacan to Maquixco Alto. It is

also possible for a campesino to purchase private property from a person living in another community. This has happened at San Pablo Isquitlan where members of that community have bought lands from San Martin found within the private property of San Martin. In addition they have bought lands from Santiago Tolman residents who in turn have purchased lands from residents of San Pablo Isquitlan.

On the basis of cases in Maquixco Alto and in San Pablo Isquitlan it appears that individuals may move from one village to another and still retain possession of their ejido lands. In such cases the lands are usually lent a medias or rented. This practice appears to be illegal according to the rules of ejido system operation.

In addition to holding private or ejido lands within the lands of another community it is possible for a campesino to use a medias or to rent private or ejido lands belonging to other villages. Although this is usually done on an individual basis there have been some cases in which a village will use undivided ejido lands of another community and pay an annual rent. Colhuacan uses the strip of Maquixco ejido which lies above the village on the slope of Cerro Gordo and pays an annual rent to the patron saint of Maquixco. Prior to the purchase of the Hacienda Hueyapan, San Pablo had a similar arrangement with Santo Domingo Aztecameca.

DOMESTIC ANIMALS

Only the turkey, of all the animals in the valley today, is a New World domesticate. All the others are of Old World origin. Although introduced to this area 450 years ago they have not become fully integrated into the agricultural system of the area. "The neat balanced symbiosis of European agriculture is lacking in highland Mexico in general." (Sanders 1957: 111). This problem warrants further investigation.

1. Fowl

Included here are turkeys, chickens, ducks and geese. Most families have a few chickens and turkeys. The eggs are eaten as well as the flesh of the birds. Consumption of the birds on a large scale occurs at fiestas when other animal foods are also eaten. Some families sell birds and eggs.

Ducks and geese are much rarer in the valley. One family owns a pair of geese in Maquixco Alto. They appeared to function more as a status symbol than as an economic asset. Ducks occur in San Pablo Isquitlan and in some of the villages in the alluvial plain of the Lower Valley.

The size of flocks of these birds varies from household to household. It should be noted that there are present in the valley a number of chicken raising farms or granjas which produce eggs and chickens for the Mexico City market. These have been developed within the last ten to fifteen years and are found in several locations, along the highway below Maquixco Bajo and the highway east of San Martin. They are commercial enterprises and are not associated with the agricultural economy of the campesinos.

2. Quadrupeds

Pigs

Pigs are raised by some households on a very limited scale. They are kept, as are the fowl, within the houselot. Usually there is a special pen for the pig or pigs. They are sold or consumed on festive occasions. The usual way of cooking the pig is to deep fat fry all of it in small pieces, including the skin, in a large pot of boiling fat. Pig skin cooked this way is considered a delicacy. Pig raising is not an important adjunct to the economic activities of most farmers. Normally only one to three are found per household.

Sheep and Goats

These two animals, introduced soon after the Conquest by the Spaniards have become an important part of the animal husbandry of the valley. With the goat and the sheep it is possible to utilize marginal lands as pasture. In the Middle and Upper Valleys, and on the northern slope of Cerro Gordo, sheep and goats are owned by a number of households within each community. They are

sold for barbacoa (barbecue) in the markets and their wool is clipped and used to make jackets and sweaters in Chiconcoac on the Texcoco plain. They do not form an important part of the daily diet of the campesinos. Their meat is usually steam cooked in an earth oven.

During the dry season, after all the crops have been harvested, sheep and goats are pastured in the cultivated fields. During the growing season they are herded in the hillside pastures. On the northern slope of Cerro Gordo there has developed a type of daily transhumance in which the flocks are taken from the village of Colhuacan each day to the top of Cerro Gordo. The herding is usually done by small boys, although in Maquixco el Alto there are some men who work as professional herders. At San Pablo Isquitlan the sheep and goats are pastured on the hills to the north of the village. Some individuals take their flocks up and down every day during the growing season but there is some evidence of a modified seasonal transhumance practiced as well. On the hill there are corrals in which sheep and goats are kept during the rainy season without being returned to the house. The members of the household rotate the duties of caring for the animals and the food for the herders is brought up daily by the women of the house.

Goats, sheep and cattle are similarly pastured in the hill areas in the Lower Valley.

Cattle

Some households in the valley raise a few cows which are bred for their milk. The exact number varies with each household. In the Middle Valley, the Upper Valley and the northern slope of Cerro Gordo the herds are relatively small, consisting of two to three animals, as compared to herds of fifteen to twenty sheep and goats. Like sheep and goats, they are pastured on hill lands or cultivated lands, depending on the season. At night they are usually returned to the house-lot and kept in stalls. The sheep and goats are usually penned in rather make-shift enclosures of brush but the stalls for cows are well built on the whole.

In San Pablo Isquitlan a number of villagers have substantial herds of dairy cattle (Holsteins) and sell the milk daily to regular customers in San Martin. These animals are usually kept in their stalls continuously.

In addition to the households that own a few dairy cattle some rancho owners and campesinos are switching over entirely to dairying. This is particularly true in the irrigated plain of the Lower Valley but occurs in most areas where adequate water is available for alfalfa growing. It was noted earlier that the Lower Valley is in a state of transition from subsistence agriculture to commerical dairy farming.

Draft Animals

Included here are oxen, horses, mules and burros. Most families have some draft animals for plowing. Oxen were once more common in the valley, but have been replaced recently by horses, mules and burros. Burros are used primarily for transporting burdens while the others are used to pull plows. These animals are pastured with the other animals of the household during the day and returned to their stable at night. The stables tend to be rather substantial

structures. During the time the animals are being worked they are fed barley. During the dry season they are kept in the villages and fed zacate (primarily dried corn stalks), and straw. Controlled animal breeding does not appear to be carried out. Horses and mules are purchased rather than raised.

3. Bees

I should mention the existence of bee raising in the valley. Usually the hives consist of old maguey trunks. Bee-keeping is an extremely rare activity and is normally the specialized occupation of a single family in each community. Colhuacan, Maquixco Alto and San Pablo Isquitlan each have one household which produces honey for sale.

4. Jagueyes

These large catchment basins, partially excavated into the tepetate and surrounded by high banks of soil are the principal source of water for the animals kept in the Teotihuacan Valley. Except for the Lower Valley, and for the few villages which have wells, jagueyes provide water for the human population as well. They are built in areas where water will drain easily into them, often via canals which have been constructed for that purpose.

Due to the erosion on the slopes the jagueyes become gradually filled with silt and have to be cleaned about once a year. It appears that this labor is carried out cooperatively by the male members of a community during the dry season when the water is low. It involves dredging the silt out with teams of draft animals.

Many of the jagueyes constructed by the haciendas are lined with stone and have very elaborate canal systems to divert water from the nearby hillslopes to them. Such elaborate systems may be seen around the Hacienda Soapayuca in the eastern end of the valley. Most of the village jagueys are circular. As a result of dredging operations carried out over a number of years, they are surrounded by high earth banks.

5. Summary

Although all of the above mentioned domestic animals are found throughout the valley the exact occurrence within each household and each village varies greatly. Thus it is difficult to make any generalizations concerning the distribution and the frequency of occurrence of domestic animals. Variations in occurrence are related to ecological factors, individual economic status and personal inclinations.

THE OPERATION OF AGRICULTURAL SYSTEMS

The various crops, domestic animals, techniques and tools of cultivation present in the Teotihuacan Valley are integrated into several agricultural systems. The household, the basic element of village social organization, is directly involved in the operation of these systems. It is through the actions of households that the many diverse elements of modern agriculture are organized into functioning systems.

In the following sections data will be presented on the operation of agricultural systems in the Lower Valley, the Middle Valley and on the northern slope of Cerro Gordo. Each system shall be analyzed by means of an examination of the nature of household participation. Then the total operation of each system will be analyzed, indicating the demographic significance of each.

Crop yield data are based on statements by informants giving the number of cargas harvested per hectare. A carga contains 100 cuartillos of shelled maize. A cuartillo of maize has a variable weight between 1.2 and 1.5 kilograms. In converting yields originally given in cargas to yields in kilograms per hectare a conversion ratio of 1.5 kilos per cuartillo has been used. Given the variable weight of the cuartillo it is possible that all figures could be reduced by 20 per cent.

1. Lower Valley - The Permanent Irrigation System

Detailed studies are available for the permanent irrigation system of the Lower Valley (Sanders 1957: 141-148; Millon et al. 1962). The system of temporal cultivation in this area has not been studied in depth. Nolasco Armas (1962) fails to make the important distinction between irrigated and non-irrigated lands in dealing with the production of lands within the Municipio of San Juan Teotihuacan. Therefore only the operation of the permanent irrigation system of the Lower Valley shall be discussed.

Household Economy-Santiago Atlatongo

Sanders (1957: 143) has presented one test case from this community. (Observations dating from May, 1954). The land studied was given the barbecho and rastreo in the previous December. Two months later, in February, the farmer applied the cruzada and the rastreo. This was followed in March by an irrigation and sowed in maize by the al tubo technique. The land would be irrigated again if the rains were delayed until June or if the August canicula (temporary cessation in the summer rains) was extended. The maize was to be harvested in September. There was some variation in the time of planting from year to year, depending on the date of the pre-season irrigation, in other years he planted in May, others in April. This would delay the harvest one or two months.

Although harvests are good at Atlatongo with little variation from year to year Sanders (1965: 38) has suggested a range of 900 to 2700 kilograms of maize per hectare with a mode of 1500-2250 kilograms over a ten year period

for the land mentioned above. Once maize was harvested the owner normally gave the land a barbecho and rastreo, followed by a cruzada two weeks later. Then it would be irrigated and planted in wheat in November. One more irrigation would be given to the field 45-60 days after planting. The farmer harvested the wheat in May. The yield per hectare of wheat averaged 1800 kilograms.

> Following wheat a rainy season crop of frijol (beans) or barley is sown, usually without irrigation. The barley usually yields from 1200 to 1600 kilos per hectare. Following the barley harvest the cycle is repeated. Frijol and squash are often sown mixed with maize. (Sanders 1957: 144)

The system followed by this farmer allows a maximum production on the land and spreads a limited water supply over as much land as possible. Since the owner of the land was a local judge and a noted abuser of water rights it is probable that the yields represent a maximum production with an abundant water supply.

Village Economy-Santiago Atlatongo

In 1960 Atlatongo had a population of 1,145 persons, a slight increase over the 1,091 living there in 1950. The data on the amount of irrigated private property vary. Sanders has indicated irrigated private property holdings of 103 hectares of which only 40 were completely irrigated the others being medio riego (1957: 141). Millon et al. list 78 hectares of privately owned lands at Atlatongo receiving water from the irrigation system (1962: 498-499). According to them the 78 hectares are divided into 112 parcels. Of these parcels 95 (85%) fall below .80 hectare in area, 10 lie between .80 and 1.9 hectares (9.5%), 6 (5.3%) are between 2.0 and 7.9 hectares with one (.7%) between 8.0 and 19.9 hectares in area. It is obvious that there is severe fragmentation of private property within the irrigation system at Atlatongo.

Although some data are available on the total size of irrigated ejido holdings no data are available on the exact size of ejido parcels. According to Sanders (1957: 141) Atlatongo held 132 hectares of irrigated ejido. Of these 100 were permanently irrigated, the rest being medio riego. Millon et al. have stated a smaller figure of 80 hectares of irrigated ejido land for the village (1962: 503). The local informants suggested that the ideal division of these lands would be into parcels of .60 hectares for each ejido holder. However a division of the 288 holders into the available irrigated lands indicates a figure of about .28 hectare per parcel. "Whether the actual division into individual parcels approaches this average we do not know." (1962: 503).

The information on non-irrigated lands pertaining to Atlatongo is limited but provides some additional data on the problem of village economy in this village. Sanders (1957: 141) lists 200 hectares of temporal private property, 35 hectares of temporal ejido lands and 95 hectares of humedad ejido property. Millon et al. (1962: 503) present a figure of 150-160 hectares of non-irrigated ejido. Sanders suggests that the range in size of parcels, including both irrigated and non-irrigated ejido is from .25 to 1.0 hectare while Millon et al. suggest a figure of .56 hectares for the non-irrigated ejido parcels, and an ideal figure of .70 hectares for the same area.

Nolasco Armas (1962: 15) sampled twenty families in Atlatongo in her study of 1960. All twenty families held ejido lands and nine also held private property. The range in the size of the pequena propiedad of each family was from less than one hectare to no more than five hectares.

As was mentioned before there is extreme fragmentation of lands within the holdings of Atlatongo. Thirty families hold the private property while many also hold ejido lands. Millon et al. (1962: 503) have reported at least ten landless heads of households in the village.

> If every farmer held an equal quantity of land with equal water rights the land could support an even larger population than it provides for today, as a full hectare of irrigated land plus 1.5 hectares of temporal land would be more than he needs to maintain a balanced economy. (Sanders 1957: 142)

An important result of the unequal distribution of lands within Atlatongo has been a severe land shortage. This has caused a number of farmers to work for others who have a large area of land. In addition some have sought work in the factories in Mexico City (Millon et al. 1962: 503).

Although the lands are unevenly distributed between the farmers until recently Atlatongo had worked out a very flexible system of distributing water. Officially all the water from the Canal de San Jose was allocated to holders of ejido parcels and none to holders of private property. Within the village, however, it was decided to allot water to ejido and private property during alternating months. This could be adjusted depending on the need of the individuals involved. Many held both ejido and private property. The system worked quite well up to 1959 but may have changed since then due to the assignment of separate volumes of water to ejido and private lands. (Millon et al. 1962: 508).

This system was possible in Atlatongo because of the rights of the village to a continuous flow of water (38.0 liters per second) from the Canal San Jose. This flow has been reduced to 18.3 liters per second since 1959 (Millon et al. 1962: 508).

In addition to the permanent flow from the Canal San Jose, Atlatongo also receives water from local springs at the rate of two liters per second. Aside from these two sources Sanders (1957: 121) has indicated that each month Atlatongo is allotted almost thirty hours flow from the Canal San Antonio. Millon et al. state that no water comes from this canal but rather from the Canal de Cadena (1962: 502).

In those lands which receive water from the permanent flow several irrigations are possible during the growing season, thus ensuring good yields. Lands which are irrigated by the monthly allotment of water receive only two irrigations during the growing season. Losses occasionally occur when the fields are sown in March and rains are delayed until July. Sanders suggests further the "Abuses of water rights within the village are common and quarrels frequent." (1957: 142). This is in contrast with the operation of the permanent supply of water from the Canal San Jose.

With the more permanent and secure water supply of the area crops tend to be varied. Sanders suggests that maize, wheat and alfalfa are, in that order, the most important crops. Other important secondary crops consist of beans, haba beans, peas, squash and barley.

> Formerly the area around the village was occupied by chinampas and most villagers cultivated onions, beets, lettuce and carrots in their solar-chinampas. Today these houselot chinampas have been converted to fruit orchards including such trees as apple, peach, cherry, apricot, pear, pomegranate and fig. (Sanders 1957: 143).

The system, of course, permits double cropping and almost continuous use of the land.

Household Economy-Calvario Acolman

In Calvario Acolman many campesinos have shifted from a subsistence economy based on grain cultivation to an "alfalfa-barley-dairy economy." (Sanders 1957: 145). These crops are less sensitive to drought. As a result the use of humidity conservation techniques is not frequent at Calvario Acolman.

A campesino planting two, successive, drought resistant crops, such as barley and alfalfa, will irrigate his land only twice each year, once before each of the sowings. With one drought resistant and one heavy water consuming crop such as wheat and maize he will irrigate three times. The maximum number of irrigations per year is three. The usual practice with the water shortage is to plant one of each type of crop in a given year.

The exact cycle any individual follows is up to his personal choice but depends upon the rather rigidly controlled supply of water.

> . . .if wheat is to be sown in the winter a farmer may be allowed two irrigations for his winter crop but with the understanding that he will then sow a crop like barley in the summer which can get along on just one or if he plans on a summer maize crop he will then sow alfalfa and not wheat in the winter. Even wheat at times may be attempted with a single pre-sowing irrigation. (Sanders 1857: 146).

It is possible, if a farmer has enough money, to rent the ejido pump-artesian well in the village by the hour and irrigate his land four times a year, once above the maximum permitted by the spring fed irrigation system.

The particular informant fertilizes his fields about once every five years. Despite deficient water and lack of careful preparation of the land, crop losses rarely occur and the yields, according to Sanders (1957: 147) are similar to those of San Pablo Isquitlan in the Middle Valley. Maize yields average 1200-1500 kilograms per hectare with a lower limit of 900-1050 kilograms. It is claimed that during the hacienda period yields were higher, due to better maintenance of the irrigation system and use of floodwater irrigation as well. The yield per hectare for wheat averages between 1000-1200 kilograms.

Many campesinos have divided their holdings into strips about seven meters wide separated by low earth walls. Some have even broken them up into small

squares or rectangles. These techniques are to ensure the even distribution of water over the field and to prevent wastage of water through uneven drainage. These techniques and the artesian well are designed to cope with the shortage of water in the irrigation system which results in lower yields per hectare compared with the more favorably situated lands of Santiago Atlatongo (Sanders 1957: 147-148).

Village Economy-Calvario Acolman

Calvario Acolman had a population of 1,062 persons in 1960, a sharp increase from the 1950 population of 720. The village is located near the entrance of the Lower Valley into the Delta. It participates in the irrigation system and is the headquarters of the Junta in charge of the system. Sanders (1957: 144) has suggested that the water situation at Calvario Acolman is more typical of the Lower Valley area in general than is the case at Atlatongo.

Most of the lands of the village are irrigated. The private property is all irrigated and totals 165 hectares (Sanders 1957: 145) or 174 hectares (Millon et al. 1962: 498). The holdings tend to be small and are owned by approximately one-half of the families of the village (Sanders 1957: 145). They are not as fragmented as those of Atlatongo. Millon et al. have stated that there are 114 parcels of private property. These include 61 parcels (54%) under .80 hectares, 31 parcels (27%) between .80 hectares and 1.9 hectares, 21 (18.4%) between 2.0 and 7.9 hectares and one parcel (.6%) over 20 hectares in size. (1962: 498-499).

The ejido of Calvario Acolman includes 218.8 hectares of irrigated land. This is divided (1953) into 116 parcels of 1.6 hectares each (Sanders 1957: 145). Millon et al. have stated a figure of 258 hectares of irrigated ejido land (1962: 502). The ejido land also includes 108.8 hectares divided into 34 parcels containing .2 hectares of tierra de humedad and 3.0 hectares of tierra de temporal (Sanders 1957: 145).

Unfortunately there are no data available on the exact landholdings of households within the village. Fragmentation is not as great as at Atlatongo and this might indicate an even more uneven distribution of land. The major problem at Calvario Acolman is a shortage of water and this is probably typical of all the villages in the Lower Valley irrigation system.

The monthly allotment of water to irrigate the lands of the village comes from three of the major canals.

> From the canal of Texcalac with a capacity of 50.6 liters per second the ejido receives water for a period of 4 days 15 hours to water 54 hectares, and the private property receives water for 8 days 13 hours 30 minutes to water 100 hectareas. From the canal of San Antonio with a capacity of 200.26 liters per second the ejido receives water for 2 days 3 hours 15 minutes to water 90 hectareas, and the private property receives it 1 day 13 hours to water 65 hectareas. From the canal of San Jose with a capacity of 287.32 liters the ejido receives water for 1 day 8 hours to irrigate 81 hectareas. (Sanders 1957: 114-145)

The reduced amount available for irrigation, due to a decrease in the output in the springs, has resulted in a shift from a grain subsistence economy to an alfalfa-barley-dairy economy. "The four chief crops at Calvario in order are alfalfa, barley, wheat and maize. The village can truly be said to be based on a fully commercial economy." (Sanders 1957: 145). The situation at Calvario Acolman is similar to that in other villages utilizing the irrigation system of the Lower Valley.

Agricultural Economy - Lower Valley

Today the area of permanent irrigation in the Lower Valley consists of approximately 3,600 hectares of deep soil plain. It is a system which is in transition from subsistence agriculture to commercial dairy farming. This is due in part to the lowered water table, reducing the output of the springs, and in part, to the growth of Mexico City as an urban market.

The extremely fragmented landholdings within the system and the unequal distribution of lands within some communities has resulted in the shift of many villages from agriculture to factory work in the city. Others work as farm laborers for other villagers.

The establishment of the Junta to run the irrigation system has not solved the basic problem of the system today, too little water. New regulations for the allocation of water, put into effect in 1959, work against the small landholder. However, even the old regulations could not deal with the lowered output of the springs. Millon et al. have summarized the problems of the system stating that "the real basis of conflict is the fact that there is not enough water in the system now to provide for the minimal needs of all the people served by it. . ." (1962: 507).

Today the villages participating in the irrigation system have a combined population of 17,026 (1960 census). Not all, of course, are directly or even indirectly supported by the crops grown within the irrigated area. However, the 3,600 hectares of irrigated land could produce enough maize to feed 19,450 persons if all lands were planted in maize and produced an average of 1350 kilograms per hectare each year. This estimate assumes an average consumption per person of 250 kilograms per year. This average is derived from statements by contemporary farmers in the Teotihuacan Valley. It actually is somewhat high since the amount needed per person per year varies between 200 and 250 kilograms according to various informants. With a reduction in the amount needed to 200 kilograms per person 24,300 persons could be supplied with maize. It must be noted that this estimate is based on the present low output of water. If the estimates by Gamio's engineers, of the former output, are accurate, then one could either use the average yield per hectare from Atlatongo of 1875 kilograms rather than that from Acolman of 1350 kilograms, or assume a fifty percent increase in land irrigated by the system. With these figures the potential population increases to a minimum of 27,000 and a maximum of 32,750.

These figures are based only on maize production using contemporary techniques. Since the whole area would not be under maize cultivation at one time and since other crops would also be grown they should be revised downward. Yet, given the more intense horticultural practices of the pre-Conquest period,

it is quite possible that the increased yields from fewer hectares of maize could make up the amount needed to support the estimated population. Thus I would suggest that the pre-Conquest irrigation system, using aboriginal crops and agricultural techniques, had the potential ability of providing basic grains to feed a population of between 25,000 and 30,000 people.

There are a number of variables to take into account when attempting to arrive at a reasonable estimate of pre-Conquest population supported by the food produced in the permanently irrigated alluvial plain of the Lower Valley. They include types of crops, amount of water, agricultural techniques, soil depth and standard of living. To examine this problem in depth would be a major research task. Since I do not control all the variables, I must leave the figures mentioned above as tentative estimates presented on the basis of the operation of the modern permanent irrigation system.

2. The Middle Valley

Detailed and extensive materials are available for several communities within the Middle Valley. The data include descriptions of the system of flood-water irrigation, temporal cultivation and the permanent irrigation system of the Hacienda Hueyapan. A summary of this information is presented in the following sections.

Household Economy-San Pablo Isquitlan

In 1954 Sanders studied the landholdings of one of eleven land owners of this community (1957: 131). The individual held as private property a parcel measuring 300 x 118 meters, slightly over 3 hectares in area. This parcel was situated on the Barranca de los Muertos "with a line of maguey sown along its barranca side to prevent erosion." (1957: 131). The land was rich, flat plain and the owner applied to it the complete series of dry farming techniques to conserve moisture. He considered it to be his household granary. The plot was inherited from his father and had been sown continuously in maize since he received it. "The holding is about average in the village for private land and has been held by the family for generations." (1957: 131). Water from the barranca is readily available for irrigation. The land in normal years received three to four irrigations. In addition to the silt deposited by irrigation some animal fertilizer was added every six years.

After carefully preparing his land the farmer sowed maize with the al tubo technique. According to him the production was equivalent to that achieved when he used the a cajete method. The amount sown included 10 cuartillos of maize mixed with 17 cuartillos of beans and 1 cuartillo of squash per hectare.

During a ten year period (1943-1953) he averaged a maize yield of 1200 kilograms per hectare. In the three worst years the yield per hectare dropped below 900 kilograms per hectare but over the seven best years the yield was between 900 and 1500 kilograms per hectare. The farmer needed 4.5 kilograms of maize daily for his family of seven or 1642 kilograms per year. This is an average of 234 kilograms per person per year. The family could therefore be

provided with annual maize needs from 1.4 hectares of land.

In addition to holding slightly more than three hectares of private property within the floodwater irrigation system Sanders' informant also had rights to the use of eight hectares of ejido which he cultivated as tierra de temporal. One hectare was loaned to a poor relative, a frequent occurrence in San Pablo. From 1951 to 1954 he planted his seven hectares in barley, switching to maize in 1955. He planned to sow it four years in maize and then return to barley for a second four year period.

The yield of barley varied between 450 and 1500 kilograms per hectare. An average yield was 500 to 600 kilograms. On the same land the 1950 maize harvest yielded 900 kilograms per hectare.

Household Economy-San Martin de las Piramides

Sanders also studied a field in the Middle Valley owned by a resident of San Martin (1957: 137). He prepared his land carefully with the barbecho-rastreo and cruzada-rastreo, sowed it with the al tubo technique and gave it light fertilizations every five or six years. The land was located just south of the Barranca del Muerto and given several irrigations during the growing season. He sowed it with maize and beans every year without rest.

According to the owner he harvested between 900 and 3000 kilograms of maize per hectare and never less than 900. He stated that his long range production was between 1500 and 2250 kilograms per hectare. From a sowing of 5 cuartillos of beans per hectare he harvested 450 to 750 kilograms.

Household Economy-Santa Maria Coatlan

Most of the private property and ejido lands of Santa Maria are cultivated as tierra de temporal (Sanders 1957: 138). The majority of campesinos plant maize and barley with a few areas in beans. Maguey occur as field borders. Fertilization sources include silting from floods and light animal fertilization every six years on the better cared-for lands. The farmers rotate crops with one year of maize, one year of barley and one year of mixed maize and beans, a common pattern.

Since these are tierras de temporal the yields of maize per hectare vary considerably, depending on the rains. The ejido lands showed a range of 450 to 1800 kilograms of maize per hectare from 1939 to 1954. In bad years, complete losses occurred on some lands and the lands that did produce, dropped to a yield of 450-900 kilograms. In good years the same lands yielded from 1200 to 1800 kilograms per hectare (Sanders 1957: 138-139).

Household Economy-San Francisco Mazapan

The temporal lands of San Francisco are similar to those of Santa Maria. Sanders studied one ejido parcel held by a farmer of San Francisco. This farmer had a permanent job in the archaeological zone and let a fellow villager use the parcel "a medias".

The parcel was one hectare in size with a soil depth of one meter. It was located on a flat, level area near the dam constructed by the Hacienda

of Tlacateupa and could have been converted to tierra de humedad since it had canal facilities. The parcel was never fertilized or rested. Barley and maize were rotated in a two year cycle.

Preparation of the land included a fall barbecho and a May sowing. If rain did not come within twenty days of planting, the seeds were lost. In most years water was available for up to five irrigations during the growing season.

The barley yields from this land fluctuated widely, with a total range of 450 to 1800 kilograms per hectare and an average yield of 600 kilograms per hectare. During a twenty-five year period, a yield of 600 kilograms per hectare was exceeded only eight times. (Sanders 1965: 39). Although barley is only rarely a complete loss maize does fail upon occasion. The maximum yield per hectare between 1950 and 1954 was 900 kilograms. This was exceeded only eight times in a twenty-five year period. The holder of the land needed 1200 kilograms of maize to support his family of nine for one year. Six of the family were small children which accounts for the rather low figure cited (Sanders 1957: 140).

Hacienda Economy-San Pablo Isquitlan

In 1951 a group of campesinos from San Pablo formed an association, borrowed 350,000 pesos from the Banco Ejidal and purchased the Hacienda Hueyapan. The loan bears interest at 5% per annum. The land purchased was primarily hillslope and temporal. However, of the sixty-five hectares located immediately next to the hacienda buildings, twenty-eight hectares are permanently irrigated from a well, equipped with a gasoline pump. Twelve additional hectares are considered to be tierra de humedad and receive water from the floodwater irrigation system. The remaining twenty-five hectares are tierra de temporal, as are the hillslope lands.

Fourteen hectares of the permanently irrigated land are used to grow alfalfa as a cash crop. The earnings are used to pay off the loan. The other permanently irrigated lands are planted in maize, which is also sold for the same purpose. The Association hopes ultimately to divide the irrigated lands among the members of the cooperative. The preparation of the irrigated lands is similar to that found in the Lower Valley irrigation system. A similar type of crop rotation also occurs. I have some data on crop yields per hectare for the irrigated lands. According to an informant the permanently irrigated lands should consistently yield 1500 kilograms of maize per hectare and this figure may be exceeded in very good years with heavy rains.

Village Economy-San Pablo Isquitlan

San Pablo had a population of 476 in 1960 and 500 in 1964. The village lies between the Barranca del Muerto on the south and the Barranca de Terrenates on the north. Above the northern barranca rises the gentle sloping piedmont of Cerro Gordo, while to the south of the village is the terminus of the long Cuahutlazingo ridge. The village, situated within the Middle Valley Plain, lies at an elevation of 2320 meters.

In Map 7 , the area in which the lands of San Pablo Isquitlan are located has been indicated. Including the Hacienda Hueyapan lands they range from an altitude of 2450 meters on Cerro Gordo del Pelon to 2320 meters on the plain. The holdings of the village including pequena propiedad, ejido and ex-hacienda lands amounting to 599 hectares in all. As noted earlier the distribution of land to households within the community is rather unequal. In Map 5-6 crop distribution and land classification of the lands held by San Pablo Isquitlan in 1964 has been indicated. In addition Map 7 locates the dams and canals of the flood water and permanent irrigation systems used by the village. A careful look at these maps will show that there is a close correlation between canal systems, soil types and crops grown.

The area of private property located north of the Barranca de Atlamajac and west of the Barranca de las Canteras includes a number of parcels recently purchased by residents of Santiago Tolman. Of the lands remaining to San Pablo 14.7 hectares are tierra de humedad and 56.3 hectares are tierra de temporal. The dam in the Barranca de las Canteras above the bridge diverts water into these fields through several canals. It also sends water to the jaguey around which the humid lands are found.

The lead canal is excavated to a depth of one to two meters into the tepetate. Some of the water is diverted down the wash-road west of the barranca, but the soils are very shallow in this area, so that only one small field is classified as humedad in this area. Canal P is a very shallow ditch which carries some water from the main canal, some of which runs down Canal Q, a tepetate surfaced road. Again, due to lack of soil recovery and maintenance devices, this water has little use.

The next cutoff from the main canal is Canal M which is about 50 cm. deep, excavated down to tepetate. The water from this canal divides into two canals (M and N) and after its junction with Canal L, (running from Canal A), provides enough moisture for the deep soil, well-cared for fields above the jaguey to classify them as tierra de humedad.

Canal A runs over tepetate directly to the jaguey. With L and K it irrigates the fields below the jaguey. These canals receive some water from Canal B to the west. Once Canal A and B reach the highway they have little water. Only two small fields receive enough water from them on a regular basis to be classified as tierra de humedad. The canals become much shallower south of the highway.

As Map 3 indicates, only three of the hectares classified as tierra de humedad in this area were planted in crops other than six month maize.

Since the floodwater irrigation of the ejido and private property south of the Barranca de Terrenates-Atlamajac is linked with that of the Hacienda Hueyapan I shall begin with a description of the latter system. For some distance above the hacienda buildings the Barranca de Terrenates is canalized. The canalization continues to the fourth dam on the barranca. The Barranca de Terrenates has one dam constructed by the hacienda which now directs water into the ejido of Axapusco. This dam is located above the lands held by the Association of San Pablo.

The second dam on the barranca is located near the buildings of the hacienda and directs water into a now used jaguey. The lead canal is from one to two meters wide and one meter deep. The water is now used to irrigate the adjacent fields, which are classifiable as tierra de humedad.

At the junction of the Barrancas de Terrenates and Estetes there is a third dam with two lead canals. Canal Y, at the dam, is from one to two meters wide and about one meter in depth. It carries water to the ejido lands of Santiago Tolman. Canal U is of similar size but leads water to the hacienda lands paralleling a permanent irrigation canal. In the hacienda lands water from this canal is used to irrigate fields that also receive permanent irrigation water.

Canal U is also a main canal for the ejido lands of San Pablo and through a series of east-west secondary canals irrigates the eastern part of the ejido lands. It becomes shallower south of the highway but continues to the edge of the Barranca del Muerto where it again has a depth of one meter.

Before the Barranca de Estetes joins Terrenates a shallow canal, about 50 cm. deep, exists and runs south. This canal, Canal X, carries both well water and barranca drainage to the fields below. About twelve hectares of this land remains temporal, however, and this portion has been divided into one hectare parcels to raise subsistence crops. Water from the Barranca de Estetes also floods a small field near the well and this is classified as tierra de humedad.

The permanent irrigation system has its source in a well. The water is pumped to a large tank in front of the hacienda building. Although there is a brick conduit raised above the ground which could carry this water to the fieldsnorth of the well it is no longer used. Those lands as well as the fields above the main hacienda building are tierra de temporal. The thirteen hectares are divided between the Association members in one hectare parcels.

The well water flows into a number of fields, located nearby, through its own canals. In addition it uses Canal X which also carries runoff. However, the well water passes over Canal U in a steel pipe as well as over the canalized Barranca de Terrenates. The fields irrigated by the well water are, with one exception, downslope, and south of the well. The system is only partially integrated with the flood water system and is best understood as a separate system of irrigation which eliminates the problem of the vagaries of flood-water irrigation.

Between the third and fourth dams the canalized Barranca de Terrenates becomes quite shallow, often having a depth of only 25 cm. At the fourth dam there are two lead canals. The one to the north carries water to the ejido of Santiago Tolman. The water is insufficient to irrigate the small parcel of San Pablo ejido on the same side of the barranca. The other canal, Canal S, runs to the south to the ejido of San Pablo. Each canal is about one and one-half meters deep and two meters wide as it leaves the dam. At this point they are bordered by earth banks. Canal S flows to the south, irrigating lands to the south and west through a series of secondary canals leading to the west. When it is joined by Canal R, the two form Canal H and run directly west into the village. Canal H is shallow, appears as a path running through the streets of San Pablo, where it collects street drainage and directs it into the fields on the west. Canals C and D are quite similar but originate

in the village. They are about 15-25 cm. deep and 30-50 cm. wide and serve to drain the village after heavy rains.

The first dam on the Barranca del Muerto leads water into the private property of Cuahutlazingo. The second dam has two canals. Canal T flows into nearby ejido lands of San Pablo and through Canal R joins Canal S to form Canal H. The other canal runs to the south, into the private property of Cuahutlazingo and San Martin, where it irrigates the fields of both. Some campesinos of San Pablo own lands in this very rich agricultural area. Each canal from the second dam is about one to two meters wide and one meter deep and has high earth banks.

The third dam has only one canal and it leads directly into the private property of San Pablo Isquitlan after first running parallel to the barranca. To control the flow of water there is a well built masonry dam with slots for gates located on the diagonal canal leading into the village. The canal turns abruptly to the west, running between low earth banks, and gradually becomes smaller as it branches into a number of cross channels such as F and G. Ultimately it reaches the Atlamajac. This canal irrigated the private lands located south of the Atlamajac. It is similar in size and construction to other canals.

An indication of the effectiveness of this system of dams and canals may be seen in the fact that only 6.4 hectares out of a total 105 hectares of ejido land are classified as tierra de temporal. Although the ejido is potentially capable of producing excellent crops it is not always planted in crops which need tierra de humedad. One result of the unequal distribution of ejido land in San Pablo (to 10 to 11 families out of 71 households) is the inability of each ejiditario to "cultivate such a large holding to the degree of intensity that his technological knowledge permits." (Sanders 1957: 131). Consequently many farmers cultivate their private lands very carefully but use their ejido lands as tierra de temporal for barley. Sanders' observation on this point is supported by the 1964 distribution of crops in the ejido area (see Map 3). Of the total 105 hectares 49.25 were planted in barley or three-four month maize, neither of which required tierra de humedad. Except for three or four hectares, left unplanted, the rest of the ejido was planted in six month maize which requires tierra de humedad to be successful. Minor crops are also indicated on the map.

This situation is in striking contrast with the private property east and west of the village in which all 60 hectares are classified as tierra de humedad and all but six are planted in six month maize. In the 56.3 hectares of tierra de temporal private property above the barranca the major crops are beans and four month corn, followed by barley in areas of shallow soil. Of the 14.7 hectares of tierra de humedad in the same area, 3.8 are planted in barley or 4 month corn.

The crops grown in the 48 hectares of private land located on the hillslope to the north tend to be barley and four month corn. All the hillslope lands are tierra de temporal although there is a possibility of building terraces and converting them into tierra de humedad. Most of the hacienda lands on the hillslope, about 240 hectares in all, are used for pasture and the growing of barley. Each member of the Association has the right to pasture his

animals and to plant one or two hectares of land in addition to this one hectare near the hacienda. The lands are very badly eroded in many areas.

Within the village five hectares are under cultivation and five are occupied by houses, houselots and streets. The five hectares include 1.75 hectares planted with six month maize, and 3.25 hectares with four month maize and/or beans and nopales with a few fruit trees. Undoubtedly the activity around houses within the village increases erosion and results in a decrease of productivity. As a result those fields which are in six month maize are on the edge of the village.

One interesting feature of crop distribution in the area around San Pablo is the high percentage of fields which contain fruit trees. These trees are found primarily in private property within the village and on the lands immediately adjacent to it. The small fields and diversity of crops planted within the private property of San Pablo agrees with Sanders' statement concerning a careful working of private property, as opposed to ejido lands.

The 65 hectares of the Hacienda Hueyapan that are located in a single block around the hacienda buildings, include 14 hectares which are permanently irrigated and under alfalfa cultivation and another 14 permanently irrigated hectares which are planted in six month maize, with some four month maize. The 12 hectares of tierra de humedad, irrigated by floodwater only, are planted in both types of maize, with some maguey and beans. The 25 hectares of tierra de temporal are planted primarily in four month maize, with some beans and barley also present.

On the basis of crop distribution within the lands exploited by the village of San Pablo Isquitlan it appears quite certain that the major crop is maize, of the two varieties. This is followed by barley as a major cash crop and in some cases by alfalfa. In addition beans, habas, and fruit trees are important secondary crops, the latter being a cash crop of importance for some farmers.

The main focus of agricultural economy is to be found within the private property on the alluvial plain and the adjacent slopes. A second lesser focus is found in the lands surrounding the buildings of the Hacienda Hueyapan. Hillslope areas and ejido lands are not primary centers of agricultural activity in San Pablo.

Although the village economy is based primarily on a subsistence agriculture, it is well to note that the degree of participation in this economy is not the same for all. This is the product of the uneven distribution of lands with 30 households having no land holdings. Twenty-nine households (40.8%) are supported by a head of the household who works for another campesino. Furthermore, another 15 (21.1%) who have some lands also engage in agricultural labor for other farmers. It should be noted that some of this work is carried out for campesinos of San Martin although many of the patron-client relations are also found within San Pablo. A full list of occupations is to be found in the paper on Settlement Patterns in which this village is described in detail. It should be compared with the lists for San Cristobal Colhuacan and Santa Maria Maquixco el Alto where land distribution is more equitable. The basic point to be made that just as an unequal distribution

of land in Atlatongo has forced many campesinos into patron-client relationships a similar shortage of land in San Pablo has resulted in a comparable situation. Many of the campesinos have tried to find a way out, as has been described, buying the Hacienda Hueyapan. It will be interesting to follow the history of that endeavor.

No detailed data is available on the size of land parcels, except in the case of the ejido. Ejido holdings in San Pablo average ten hectares per ejiditario. The individuals who are members of the Association of the Hacienda Hueyapan have one hectare of tierra temporal each and the right to use the communally held hillslope. For private property I can only suggest that if it were equally divided between all holders of private property then the average parcel would be just under six hectares in area. To the best of my knowledge, however, the sizes vary considerably, and some individuals hold only one or two hectares while others have over a dozen. The former situation is more common but I do not have accurate figures for the entire village.

Village Economy-San Martin de las Piramides

In 1960 San Martin had a population of 3,197. The village holds today and has held since the 16th century the rich alluvial plain between the Barrancas de Atlamajac and del Muerto, reaching as far east as San Pablo Isquitlan. This is pequena propiedad and consists of nearly 100 hectares of floodwater irrigated land.

> It is mainly given over to maize cultivation with most fields being bordered by maguey. Barley and frijol are important secondary crops. The general depth of soil over this zone is from 2 to 2.5 meters. Those strips of flat land within 100 meters of the two arroyos, especially the Muertos, are the most productive due to their natural humidity and facility for artificial irrigation. The best lands of all are south of the Muertos, especially those further upstream. All of the pequena propiedad has facilities for irrigation, based on two sets of dams, and the canals are carefully maintained. (Sanders 1957: 134).

According to Ortiz and Aparicio the pequena propiedad is held by 717 landowners (1966: 1). In addition to the private holdings there are 500 hectares of ejido held by the village. Of the 500, 250 hectares were taken from the Hacienda of Cerro Gordo. The lands are on the edge of the gentle sloping piedmont and extend into the plain. They have gentle slopes and between 30 and 100 cm. of soil cover. When owned by the hacienda they were covered with maguey bancals and the metepantles were sown with barley and beans. Some maize was grown through the use of irrigation from the dams on the Xalmeyo and the San Martin. With the appropriation of the lands, the maintenance of the dams and canals ceased. The maguey have not been replaced and the area is "used mainly for temporal farming of maize and barley and the production has declined sharply from the hacienda level." (Sanders 1957: 134).

As I mentioned in the discussion of the dams of the floodwater irrigation system the people of Tolman and San Martin cooperated to clean out the canals

and repair the dam on the Xalmeyo. It was hoped that this would convert the area into tierra de humedad.

In addition to the lands from the Hacienda Cerro Gordo 80 hectares were taken from the Hacienda of Tlacateupa and 160 from Oztoyahualco.

> These lands are mainly slopes with a scanty soil cover, in some exceptions with surface tepetate, and are the poorest lands held by the village. They were originally devoted to stock raising and maguey cultivation but today are tierra de temporal and sown in grains to produce exceedingly precarious and low-yield crops. These lands really should be reconverted to maguey. Part of them lie in the tlatel area of the ruins. (Sanders 1957: 134-135).

Besides the ejido and private holdings, the houselot nopal orchards are of importance in San Martin. According to Sanders the average size of a houselot was .2 hectares. This is not really a useful statement since, as he points out, the lots near the plaza are smaller and more urbanized while those some distance away tend to be larger and contain the bulk of the nopal.

As I mentioned earlier (Sanders,1957)Sanders has suggested that the division of both private property and ejido lands within San Martin is quite equitable. The range in private holdings is not great with no one having more than 10 hectares and most having less than 5. The average was 2 hectares per campesino in 1954. The average in 1966 has dropped to 1.25 hectares due to the growth of population between the two dates.

The 136 ejiditarios who live in San Martin each received 2.5 hectares of ejido land, 1 hectare from the Hacienda of Cerro Gordo, 1 hectare from Oztoyahualco, and .5 hectare from Tlacateupa. In addition each received a .25 hectare parcel just below the dam on the Barranca de San Martin, land which can almost be classed as permanently irrigated. The 49 ejiditarios who live at the rancheria Oztoyahualco received 2 hectares each,one in Cerro Gordo lands and the other in the lands of Oztoyahualco. (Sanders 1957: 135-136).

The number of persons holding ejido lands is small because the local priest discouraged them from applying (Sanders 1957: 135).

> The economy of the village, then, is based on 1000 hectares of rich vega in private holdings, 500 hectares of ejido of which half could be converted to productive grain-producing land and the rest serviceable as maguey land, and 100 hectares of nopal orchards. The holdings in general are very small (Sanders 1957: 135).

In addition to the agricultural basis of the economy of San Martin there are a number of small factories and shops present. The village has witnessed a rural-urban shift in its center since becoming a municipal center. Only 71% of the population considers agriculture as their principal occupation (Ortiz and Apanicio 1966: 5).

Village Economy-San Francisco Mazapan

Both San Francisco and Santa Maria Coatlan are only partially dependent on agriculture.

> They hold the poorest lands of the valley and rely in part on specialized handicraft industries. Also many men work for the federal government as laborers and caretakers at the ruins, some sell to the tourists and many commute daily to Mexico City as factory workers. Almost all villagers further own nopal orchards as a source of cash income. Aside from the poor quality of the land then, most men have secondary occupations and agriculture is only half-heartedly carried out. (Sanders 1957: 137-138).

In this area the best lands are south of the ruins with a soil depth of 30-100 cm. A fraction could be cultivated as tierra de humedad but more could be irrigated if dams were installed to control the barrancas. North of the ruins the soil is thinner, frequently less than 30 cm. and with large areas of bare tepetate.

San Francisco, with a population of 1143 in 1960, holds 270 hectares of ejido divided into parcels of 1 to 2 hectares and distributed to 132 families. Sanders has suggested that land division was equitable and that very few families hold over 3-4 hectares with ejido and private holdings combined. The recent survey by Nolasco Armas tends to support this generalization. She interviewed 20 families in San Francisco. Among the families there were 24 ejiditarios. In no case did the pequena propiedad of a family exceed 4.9 hectares. (Nolasco Armas 1962: 15). Sanders was not able to ascertain the size of the private property of San Francisco Mazapan. The majority of the lands are cultivated as tierra de temporal.

Village Economy-Santa Maria Coatlan

The lands worked by Santa Maria and the general orientation of the farmers are very similar to those described for San Francisco. Sanders did not determine the size of private property in Santa Maria but has stated that the village holds 161 hectares of ejido lands, 98 of which are divided among 53 ejiditarios in 1 to 2 hectare parcels. "The rest of the ejido is communal hillside pasture." (1957: 138). He suggests that the individual holdings are similar in size to those of San Francisco Mazapan. Nolasco Armas (1962: 15) interviewed ten families in Santa Maria Coatlan. Of the ten families, one had propiedad holdings which when totalled, fell into the range of 5 to 30.9 hectares (1962: 93). Four other families had parcels of pequena propiedad whose total area fell between .1 and 4.9 hectares. Nine of the ten families possessed ejido lands. The lands are cultivated as tierra de temporal. In 1960 Santa Maria Coatlan had a population of 517.

Agricultural Economy-Middle Valley

Agriculture in the Middle Valley involves the widespread use of two systems, floodwater irrigation and temporal cultivation, and the more restricted use of presas, terraces and permanent irrigation. Permanent irrigation appears to be a recent innovation in this area and is not of major economic significance.

Presas are uncommon although a few are being constructed on Cerro Gordo. Most presas cultivated are silted dams once used for floodwater irrigation. Terraces, which may have been common in the medium to steep slope areas in Prehispanic times, are under construction in slope areas both on the north and south sides of the Middle Valley. Only a few systems of terraces exist today and these are associated with villages in the slope area.

I have previously discussed the production of permanently irrigated land in the Lower Valley and the yields from the very small system in the Middle Valley seem comparable. In treating the northern slope of Cerro Gordo yields of presas and terraces will be discussed. Suffice it to state here that the yields from both compare favorably with yields from floodwater irrigated lands in the Middle Valley.

In the Middle Valley there are areas on both sides which are favorable for terraces. Approximately 900 hectares on the northern slopes and 600 hectares on the southern slopes could be terraced. Only limited terracing occurs in these areas today with most of the land being used as pasture or occasionally cultivated with techniques used with tierra de temporal. The soil cover is thin and frequently quite badly eroded. The production of most of this area is quite low and its major use is as pasture. Some maguey cultivation also occurs in this area.

Below the steep and medium slopes on the south and north side of the valley lie the gentle piedmont areas. Although floodwater irrigation is practiced in some parts of the piedmont areas most sections are cultivated with temporal techniques. There are approximately 750 hectares on each side of the Middle Valley which would be amenable to floodwater irrigation. In the past many of the haciendas introduced such systems but they have for the most part fallen into disrepair (e.g., San Martin). I would suggest that between one-third and one-half of this area is supplied with water, through functioning floodwater irrigation systems today. Even where these systems are functioning, however, much of the area remains tierra de temporal due to the inadequacy of care both of the soil and of the water distribution system. Thus in the case of San Pablo Isquitlan with 71 hectares of piedmont area only 14.7 (21%) are tierra de humedad . The other hectares are tierra de temporal and cultivated as such. If the San Pablo holding may be taken as typical of the piedmont portion of the valley then the following evaluation may be made. Dam and canal systems have been constructed to reach maximally only 50% of the lands; in some portions of the piedmont perhaps one third of the lands are served from the system. In areas where the percentage rises to 50 perhaps (this involves a total of 1500 hectares in all from the Middle Valley) ten percent or 150 hectares can be classified as tierra de humedad. In the sections of the piedmont where only one third of the land is served by floodwater dams and canals (another 1500 hectares) this percentage of tierra de humedad drops to 6.6% or approximately 100 hectares.

A further point based on the examples of San Pablo and San Martin should be made. Even when lands are tierra de humedad there is no guarantee that they will be cultivated as such. That depends on other factors as I have mentioned before. Thus the lowest figure of 100 hectares of tierra de humedad could be further reduced. Thus the present use of the piedmont area would seem to be much below its potential if floodwater irrigation were conscientiously

applied.

Although the greatest area of potentially cultivable lands of the Middle Valley lies in the piedmont and slope areas (3000 hectares), the lands which produce most of the crops today are in the floodwater irrigated alluvial plain; an area of approximately 2600 hectares. There is a strong possibility that the plain became the critical area of agricultural production during the Colonial Period as a result of erosion of soil from the surrounding slopes. This erosion occurred as a result of depopulation and the reduction policy which left many terraces uncared for. If this were the case the hillside and piedmont areas would have been considerably more productive during the Aztec period.

With respect to the situation in Aztec times the most probable reconstruction would be as follows. Although undoubtedly a significant agricultural resource the Middle Valley alluvial plain before the Conquest was not a critical one. If the piedmont and hillside were covered by terraces, as the archaeological data demonstrates, most of the surface runoff would be captured before reaching the plain. There would be a general tendency of underground drainage to flow towards the plain ameliorating the situation somewhat. Under these conditions the presa and caja type of flood water system becomes non-functional. The alluvial plain of the Middle Valley could be described as simply the lower end of the two terrace systems. This impression would be further heightened by the presence of maguey bancals within the plain.

Although the present day technology of moisture preservation in tierras de humedad is essentially of Hispanic origins, nevertheless a combination of repetitive deep hoeing combined with cajete planting could have functioned as a Prehispanic equivalent. In fact Sahagun describes a comparable pattern of land preparation which we quote in full.

> "El labrador es dispuesto, recio, diligente y apto para la labranza. El buen labrador es fuerte, diligente, y cuidadoso, madruga mucho por no perder su hacienda, y por aumentarla deja de comer y de dormir, trabaja mucho en su oficio, conviene a saber, en romper la tierra, cavar, desverbar, cavar en tiempo de seca, desmontar, allanar lo cavado, hacer camellones, mollir bien la tierra, arreglarla en su tiempo, hacen linderos y vallados, y romper tambien la tierra en tiempo de aguas, saber escoger la buena tierra para labrarla, hacer hoyos para echar la semilla y regarla en tiempo de seca; sembrar derramando semillas, agujerar la tierra para sembrar los frijoles, cegar los hoyos donde esta el maiz sembrado, o acohombrar o allegar la tierra, a lo nacido: quitar el vallico, entresacar las canas quebrandolas, y apartar las mazorquillas, y quitar los hijos de estas y los tallos, porque crezca bien lo nacido, entresacar a su tiempo las mazorcas verdes; al tiempo de la cosecha, quebrar las canas cogiendolas, recoger el maiz cuando esta ya bien sazondao; desollar o desnudar las mazorcas, y atar las unas con otras, anudando las camisillas una con otra, y hacer sartales de mazorcas atando unas con otras, y acarrear a casa lo cogido y ensilarlo; quebrar las canas que nada tienen aporreandolas, trillar, limpiar, aventar, levantar

> al viento lo trillado. El mal labrador es muy negligente, haragan, y al el se le hace grave y molesto todo tradajo; en su oficio es tosco, bruto grosero, villanazo, comillon, escaso, enemigo de dar, y amigo de tomar."
>
> Sahagun, 1946, pp. 201-202
> (The italics are mine)

Floodwater systems of the caja y presa type were found however in other portions of the Teotihuacan Valley in Aztec times. Armillas, Palerm and Wolf (1956) and Millon (1957) have described a small dam and canal system between Cerro Maravillas and Cerro Atlatongo which appears to have been constructed prior to the Conquest for floodwater irrigation in a small tributary valley.

Such systems were probably found in areas where terracing was of minor significance or where valley floors were extensive in proportion to nearby hilly terrain. Such is the case in the tributary valleys north of Cerros Malinalco, Maravillas and Chiconauhtla. The total area irrigable from this system was small and it was of marginal economic significance. With the erosion of the terrace systems on the hillslopes after the Conquest the alluvial plain as a resource became critical. In addition, both water and soil were added to the plain at this time increasing both its depth and humidity. With the introduction of floodwater dams and canal systems it was possible to turn most of this area into tierra de humedad, using first aboriginal cultivation techniques which were later replaced by Spanish tools and techniques of landworking. According to Foster (1960: 58) the procedure of plowing the field crossways was necessary to break the soil since "the traditional Spanish plows lack mold boards. . .". This has become adapted as a humidity conservation technique in the Teotihuacan Valley.

Approximately two-thirds to three-quarters of the Middle Valley alluvial plain is under effective floodwater irrigation today. In hectares this would be from 1730 to 1950 hectares of tierra de humedad. The rest of the area is cultivated as tierra de temporal. These figures are only approximations as precise data is available only for San Pablo Isquitlan.

There are eight communities which exploit the floodwater irrigated alluvial plain today. Their total population is 9,528 (1960 census). Of these San Martin holds by far the largest portion of the area. As in the case of the permanent irrigation system of the Lower Valley not all persons are directly or even indirectly supported by the crops grown within the floodwater irrigated plain. However, with the partial exception of San Martin, all the communities are predominantly agricultural. In addition to the villages the Hacienda Metepec has substantial holdings in the plain.

Maize yields vary within the floodwater system. Using a figure of 1200 kilograms per hectare in a good year, which is a minimal yield, a population of at least 10,380 persons could be supported with 200 kilograms of maize per year on 1730 hectares of tierra de humedad. If all 2600 hectares were under cultivation as tierra de humedad this figure would increase to 15,600. A more reasonable estimate would be to raise figures by 50%.

However, if the plain were cultivated as predominately tierra de temporal, then the yields and population figures would decrease considerably. Using an

average figure of 1000 kilograms of maize per hectare a population of 11,000 could be supplied with 200 kilograms of maize each per year from the 2600 hectares of the alluvial plain cultivated as tierra de temporal. An additional 1,125 could be supported if the 255 hectares of the Upper Valley alluvial plain are added. If my speculations about the aboriginal situation in the plain are correct then this would approximate the pre-conquest situation, with, of course, the reservations stated earlier in connection with similar statements about the Lower Valley permanent irrigation system.

The hillslope areas today are also exploited by the communities around the alluvial plain, but to a limited degree, as a source of food. If these areas were covered with terraces or dam and canal systems for floodwater irrigation their importance would increase. An additional 9000 persons could be supplied with 200 kilograms of maize per hectare. With 3000 hectares the figure would be doubled to 18,000. It is possible that this was the pre-Conquest situation in the Middle Valley.

Regardless of these speculations about the pre-Conquest population in this area it is quite evident that three-quarters of the alluvial plain cultivated as tierra de temporal today can supply the maize needs of the population surrounding it. Thus we find that the lack of full utilization of alluvial plain, piedmont and medium to steep slopes is linked with the adequate basis of food supply in the partially utilized plain.

One point should be noted, however, that the village of Santiago Tolman has some campesinos who hold ejido lands on the Gulf Coast, in the state of Vera Cruz. These lands are used to raise cash crops. Their significance to the village is not known and would bear investigating.

In addition to the areas of the Middle Valley already mentioned there remains the tlatel zone of the old city of Teotihuacan. This underlies the communities of San Martin de las Piramides, San Francisco Mazapan, Santa Maria Coatlan and San Sebastian. It is in this area that nopal cultivation is highly developed within houselots and occasionally in fields around the communities. It is of major economic significance for most of these villages.

3. Cerro Gordo-North Slope

Fieldwork by Sanders in the fall of 1963 and by the author during the first four months of 1964 has supplied some detailed data on the operation of terrace, presa and temporal cultivation on the northern slope of Cerro Gordo.

Household Economy-San Cristobal Colhuacan

I examined in detail the landholdings of one campesino in this village. His house was constructed on the lower part of the new terrace system which rises above the jaguey. The lot was one-third of a terrace which had been divided among several sons and covered perhaps .05 hectares. It was not cultivated, except for a few maguey, having lost most of its supply of fresh soil and water because of the more recent construction of terraces above it. Use of the terrace as a houselot had also decreased its fertility. Below the

houselot terrace the campesino holds a fraction of a hectare (.05) of tierra amarilla (yellow earth) which receives both water and lama from Cerro Gordo. In the spring of 1964 it was planted in six month maize with squash. It too is located on a terrace. This land was planted a rabo de buey sowing 12 to 15 cuartillos of seeds per hectare. The calculated yield per hectare of this small terrace is 2250 kilograms. The plot yielded about 115 kilograms of maize in 1963 with an undetermined quantity of squash. The land is considered to be tierra de humedad.

In addition to the two small terraces associated with his houselot this farmer also holds as pequena propiedad 1 hectare of tierra negra within the old terrace system preserved to the east of the village. The terrace has a soil depth of about 1.5 meters at the front and 1 meter at the back. It fronts directly on a road and is supported by a stone and earth wall topped with maguey. Since it is at the lower end of a row of terraces it no longer receives much lama or water and is classified as tierra de temporal. It was planted in April of 1964. The yield in 1963 had been low (900 kilograms) because of excessive weeds. A good yield from this terrace is 1500 kilograms. It usually produces 1050 to 1200 kilograms of maize.

Below the road, on a tongue of land between two deeply eroded barrancas, the informant holds a fourth parcel of private lands. These comprise two hectares of land with a thin (15-20 cm.) soil cover composed primarily of tierra blanca de tepetate (white tepetate soil). The little soil there is has been retained through the use of maguey and earth bordos. They were originally constructed to build true terraces but the soil never accumulated. This is no doubt due to the construction by other campesinos of terraces above. The fields are planted in maguey rows and barley. They produced 750 kilograms of barley per hectare in 1963. That much barley is used by the informant to feed his animals during the year.

In addition to the lands which he owned, the informant also worked a medias some lands belonging to his mother. These lands, one hectare in total, are situated above and below his mother's house. They are terraces, (tierra de humedad), yielded about 2100 kilograms of maize in 1963.

Besides his use of pequena propiedad the informant also holds three parcels of ejido lands. Only one of these included any terraces and those were just under construction. The terraces were planted in barley in 1963. The yield was negligible owing to the shallow soils (ca. 75 kilograms per hectare). About one hectare was under cultivation.

The Colhuacan informant also owns a presa of about one hectare. Although this is classified as tierra amarilla it apparently receives little soil or water, due to its specific position in the barranca. However, it produces 1500 kilograms of maize (six month variety).

In the ejido lands of Colhuacan east of the village on the lower slopes of Cerro Gordo the informant holds two parcels of unterraced land located on a relatively long flat ridge top. Both parcels are classified tierra de temporal, and tierra blanca. They were planted in barley and maguey in 1963 and 1964. One parcel is three hectares in area, the other about one hectare. Barley yields vary with 750 to 900 kilograms per hectare in poor years and

and 1500 kilograms in good years. The maguey are raised for pulque manufacture. He ships 400 liters a week to Sta. Isabel Iztapan, selling it at 30 centavos a liter. The income derived from sales of pulque and barley goes to buy beans, an item which is not raised by most families in Colhuacan. Part of the barley is also used for the animals.

Household Economy-Santa Maria Maquixco el Alto

One informant in Maquixco Alto owned no terraced private property except his house lot. He did, however, hold extensive ejido lands, some of which were terraced. The terracing is not true stone wall terracing but bancal terracing with maguey and earth banks.

One of these holdings is located along a barranca edge above the colonial highway to San Juan Teotihuacan. It consists of about 1.5 hectares of tierra de humedad with a depth of two to three meters. The land is also considered to be tierra negra and parts of it are migajon. It is maintained with bordos of earth planted with maguey. In 1963 it was planted in maize (6 month variety), beans, squash, and potatoes. The maize yield was about 15 cargas per hectare (2250 kilograms). This parcel at times suffers from too much water from the barranca.

In addition to this parcel of ejido he also holds another (1 hectare) in the same area, but to the south, along the barranca. It is similar to the other parcel in all respects including yield per hectare. The yield per hectare has dropped as low as 1050 kilograms of maize in bad years. It is probable that the average yield would be about 1350 kilograms per hectare.

Within the large presa constructed by the Hacienda San Cayetano the same informant holds one-half a hectare of ejido lands. The soil is good, considered amarilla, and is from five to six meters deep. Because of the distance from Maquixco Alto this land is usually given a medias to a campesino from Teacalco. It produces 1800 kilograms of maize per hectare.

In addition to this parcel he also holds two presas of one hectare each on the north side of the highway in the other section of ejido land. One of these he recently transferred to the name of his son-in-law who lives with him in the same household. One presa has very thin soil and is planted in four month maize with haba beans. It is humedad, but, due to its location, little soil collects. The other presa, constructed by the Hacienda Salinas, yields from 2700 to 3000 kilograms of maize in good years and from 1200 to 1500 kilograms in poor years. It is considered to be tierra amarilla and de humedad, an excellent presa. The soil in this presa has a depth of over six meters.

On the flat ridge just above and below the old Hacienda San Cayetano he uses several parcels of unterraced ejido, all of which are tierra de temporal, although the soil depth varies.

South of the hacienda ruins he holds three hectares of ejido in two parcels of one and two hectares each, rents one hectare and uses several hectares a medias. His own ejido parcel of two hectares, also unterraced, has a soil depth of 20 to 25 cm. of tierra blanca. In 1963 he planted it in maize and

barley between bordos of maguey. It is located in the area of erosion south of the hacienda. His other parcel bears the name La Ladrillera because the hacienda kiln was located there. The soil is about one meter in depth, part tierra negra and part tierra blanca. In 1963 he planted both maize and barley. It is also in the eroded area south of the hacienda. In 1963 he rented an additional one hectare parcel which is located just inside the area of deep soil bancal terraces south of the hacienda, (see Map 9). It had some bancal terracing with soil classified as negra and about one meter deep. He planted barley in 1963. Another seven hectare parcel is ejido, assigned to a brother-in-law who has moved to Mexico City. The informant uses it a medias leaving every second pile of barley (cut) in the field. The holder of the land must make his own arrangements for threshing. This parcel varies in soil depth from 20 to 25 cm. to 1 meter and includes within it, eroded area and soil. It was planted in barley in 1963.

In the area north of the hacienda buildings he holds two parcels of one and two hectares respectively, uses a medias five hectares and his son-in-law uses and presently controls six hectares of ejido formerly held by the informant's brother. The two parcels he holds personally are in the deep soil area with maguey bordos and a soil depth of two meters. The soil is tierra negra. One hectare was planted in maize and yielded 1050 kilograms. The other two were planted in barley in 1963. Within the same area are the five hectares held by his mother-in-law. The soil is very deep (2-3 meters) and retained by lines of maguey. Since the land is close to the hacienda it was covered regularly with ashes as fertilizer and the soil is described as being ashy. In 1963 the entire five hectares were planted in barley, and in 1964 one-half were in barley, the other half being in four month corn. The six hectares worked by his son-in-law are outside the deep soil area and are located on an eroded edge of the barranca. The soil varies from 20 cm. to 1 meter in depth. In 1963 it was planted in barley and beans with some rows of maguey.

My informant also holds three hectares of ejido on the north side of the highway. The soil in this parcel is tierra blanca and varies between 20 to 25 cm. in depth. In 1963 all three hectares were in barley.

In addition to his ejido lands the Maquixco Alto informant also owns three small houselots within the village. He grows nopal on each of these, marketing a large part of the harvest as a cash crop. Barley and pulque also provide him with a relatively large cash income. In 1963 he harvested, from all of his lands, 18,300 kilograms of barley for himself and 6000 kilograms for his brother-in-law. This sold at 60 centavos a kilo.

Village Economy-San Cristobal Colhuacan

San Cristobal had a population of 306 in 1960 and 320 in 1964.

Map 9 indicates the location of the ejido and private lands of Colhuacan and Maquixco. Those of Colhuacan are confined to the slopes of Cerro Gordo and Buenavista. As I have mentioned earlier land distribution within the village appears to be rather equitable. A large percentage of the ejido lands are communal pasture. A total of 1,148 hectares are exploited by the campesinos. Maps 10-11 indicate crop distribution and land classification within the pequena propiedad of Colhuacan in 1964. I do not have similar data

for the ejido lands but my impression is that only about 10% of the ejido is under cultivation, the rest being hillslope pasture or eroded terrain. The cultivated areas are located on the long ridges running from Cerro Gordo east of Cerro Jaltepec and on the flat, plain-like area to the east of Cerro Buenavista.

Within the pequena propiedad the major areas of crop production are the presas and the terrace systems. All presas are classified as tierra de humedad and are prepared as such. Only some terraces are tierra de humedad, others because of age, position or residential use, being tierra de temporal. Preparation techniques vary accordingly with careful preparation given to the humedad lands. These are planted in March and early April with six month maize. The temporal lands are planted later in April and May, usually with four month maize,although some barley occurs as well.

Including the presas, constructed in barrancas south of the pequena propiedad in the ejido of Maquixco Alto, which the residents of San Cristobal have permission to use, the total area of presa cultivation approximates 10 hectares. Virtually all are planted in six month corn regularly except those that have suffered from erosion. The most impressive system of presas is found in the Barranca La Garita which flows to the west and collects water and soil from several smaller barrancas. As a result of the sudden loss of force of the rapidly flowing water as it turns into the main barranca from the tributary barrancas and, hence, the large quantity of silt deposited, an extensive presa system could be constructed here. The barranca is completely filled in for a distance of 800 meters with smaller presas present in immediately adjoining tributary washes and gullies. Other presas occur above the village in the upper reaches of the Barranca de San Cristobal but do not reach the size of those further down slope.

There are six systems of terraces within the pequena propiedad of Colhuacan. Three appear to be quite old, possibly pre-Conquest, in date, two are more recent and were probably constructed within the last hundred years, and the sixth has been constructed since the agrarian reforms.

On the west side of the Barranca de San Cristobal there are 13 hectares of terraces owned by campesinos of Colhuacan. The terraces lie below Cerro Aguatepec and are part of a much larger complex of terraces which runs below the smaller hills that circle the base of Cerro Gordo. The other terraces are within the lands of Maquixco Alto. Those of Colhuacan are well kept, deep soil (1-2 meters deep) terraces which receive runoff from the hill. I do not have precise data on their classification but about one-third appear to be humedad. The predominant crop grown is maize, plus about two hectares of barley. These appear to be very old terraces. A colonial road, built before 1580, is integrated with the system suggesting a great antiquity for it. (Map 8, Area 6)

On the eastern edge of the barranca there are three rows of terraces which converge at a point just within the modern village. The form of the terrace system is similar to an ancient terrace system within the lands of Maquixco Alto that was directly associated with an Aztec archaeological site. It is possible that they too have a substantial antiquity although some parts have been recently rebuilt. The system contains about 13 hectares

of land in moderate to poor condition with generally thin soil and crops of barley, four month maize, nopal or pasture. About four hectares were planted in maize, two in barley, the rest being left as pasture or planted with maguey and nopal. The presence of eroded areas on both sides of the system suggests that it may represent a remnant of a formerly more widely extended system. (Map 8, Area 7)

Above the convergence of the rows of terraces lies part of the village. This section below and just above the jaguey appears to have been constructed during the nineteenth century (on the basis of statements about the age of the terraces). It includes about seven hectares of land, most of which is as low in productivity as the tierra de temporal terraces in the system below. Most of the area is occupied by houselots with maguey, nopal and some beans. (However, .5 hectares was planted in four month maize and .5 hectares in six month maize in 1964). (Map 8, Area 8)

This system forms part of the base for the fourth system, which rises above it to the south, and which has been constructed since the agrarian reforms. It too is included within the occupied area of the village but because of its recent construction and higher position, it has a much greater productivity. It has effectively controlled sheet erosion above the jaguey and gully erosion to the east. Similar terracing activities have been carried out just east of and below the jaguey but with less success due to the prior construction of terraces (and some presas) on the slope above. Since all have been constructed after the reforms, I have included them as part of a single system. For the same reason I would also include the terraces constructed to the east above the fifth terrace system (to be discussed later). In all these recently constructed terraces, with few exceptions, soil accumulation and water contentare high and high crop yields occur. (Map 8, Area 9)

These recently constructed terraces contain about 13 hectares of land. Five hectares were planted in six month maize, four hectares in four month maize, and four in barley in 1963-64. The barley occurs primarily in the lower parts of the system, the six month maize on the edges and upper parts. The distribution of crops is directly related to humidity of the soil.

East of the village and separated from it by gully erosion, is the most extensive terrace system of Colhuacan. It covers 30 hectares and appears to be a remnant of an older system which has been partially destroyed by sheet and gully erosion. The soils are quite deep (2-3 meters) and well cared for. Most of the system is tierra de temporal. About four hectares were planted in six month maize in 1963-64. These are tierra de humedad and for the most part are located on either the upper edge or the sides of the system. An equal number of hectares were in barley. Three hectares are in pasture and one-half hectare is occupied by the village cemetery. The other eighteen and one-half hectares were in four month maize. (Map 8, Area 10)

It is possible that this system is representative of relatively well-cared for systems of terraces in aboriginal conditions. Undoubtedly the pasture area would be reduced but the proportion of humedad to temporal lands would be about the same in a functioning terrace system.

On the lower slope of Cerro Buenavista, above the Barranca La Garita, there is an old terrace system. It probably was constructed in the nineteenth century. The system includes about twenty-five hectares, all tierra de temporal. Three are planted in four month maize, six in barley and the rest are pasture with maguey (1963-64). (Map 8, Area 11)

Thus of the total 216 hectares available to Colhuacan only 78.5 were cultivated with maize or barley. Of these 23.5 hectares were planted in six month maize, 37 hectares in four month maize and 18 hectares in barley. The rest of the area consists of hillslope, barrancas and bare tepetate. In an exceptional year the area under maize cultivation could produce 126,000 kilograms of maize, using figures of 3000 kilograms per hectare of humedad lands and 1500 kilograms per hectare of temporal lands. A population of 630 could be supported with this quantity of maize estimating a consumption of 200 kilograms per person per year. In a poor year, however, the yield from the same lands could drop to 68,500 kilograms, using figures of 1200 kilograms per hectare of humedad soils and 900 kilograms per hectare of tierra de temporal. With an annual consumption of 200 kilograms of maize per person a population of 342 could be supported. If the yield from these lands were to fail completely, which has occurred occasionally, no maize would be available. Consequently, it can be seen that given a series of poor years coupled with some years of total crop failure the area of pequena propiedad under maize cultivation at the present would be inadequate to support even the modern population.

Only three (5.2%) of the residential units in Colhuacan hold neither ejido nor private lands. Only four households (7.0%) are supported by activities other than those connected with agriculture.

The focus of agricultural activity in Colhuacan is on the terraces and the presas, which together produce the bulk of the maize consumed. Maguey and barley are important cash crops grown in peripheral areas within the ejido and pequena propiedad. An examination of the barrancas and eroded zones within the pequena propiedad suggests that many are of post-Conquest origin. It is probable that prior to depopulation the entire slope area may have been terraced. Of this terracing only a fraction remains today.

Village Economy-Santa Maria Maquixco el Alto

In 1960 Maquixco el Alto with its colonias had a population of 408. By 1964 this had declined to 387. The majority of the population live in the village area located on a flat ridge top between Cerros Aguatepec and Tiquimil. There are a few outlying residences on that ridge as well as on the ridges to the southwest of the village. The inhabited area lies between 2500 and 2600 meters although the village itself does not exceed 2550 meters in elevation.

I have indicated in Map 9 the pequena propiedad and ejido lands of both Colhuacan and Maquixco Alto. I have previously discussed the distribution of land to the households (residential units) within each community (pp. 334-344). Taking my informant at Maquixco Alto as an example it would appear that there are some abuses within the system of ejido holdings. Further, fewer households of Maquixco Alto hold pequena propiedad than is the situation in Colhuacan.

The campesinos of Maquixco Alto exploit 380 hectares of pequena propiedad and 969 hectares of ejido. I have indicated in Map 10-11 the 1963-64 crop distribution and land classification for areas of both ejido and pequena propiedad for which data are available. In addition I have included the available data for the adjacent lands of Teacalco. In some cases information on the type of maize planted was not available and I have indicated all such instances as maize temporal.

Between 20% and 25% of the ejido is under cultivation. The major cultivated areas are near the ruins of the Hacienda San Cayetano and on the flat fields east of Cerro Buenavista. With the exception of a few good fields scattered through the ejido, the rest of the area tends to be hillslope, used as pasture or badly eroded.

Within the pequena propiedad of Maquixco Alto the terraces and presas are areas of major maize production. Presas are present in many barrancas but there is a concentration in the Barrancas of San Cristobal and Tecorral. All presas are classified as tierra de humedad and are regularly planted in six month maize. The total area of the presas is nine hectares. There are no large systems of presas comparable to those found at Colhuacan.

There are four major zones within which terraces occur in the pequena propiedad. The first zone is north of the Barranca Tecorral on the lower slope of Cerro Buenavista. The old terrace system previously described for Colhuacan continues into the lands of Maquixco Alto. Of the twenty-eight partially terraced hectares, only one was planted in temporal maize. Five hectares were in barley, ten in pasture and twelve hectares are bare eroded tepetate. (Map 8, Area 1)

The second zone of terrace construction lies to the west of the first but is still on the north side of the Barranca Tecorral. It is similar to the first but is not quite as badly eroded. Of sixteen hectares one was planted in four month maize, three were in barley, nine in pasture, with three of eroded tepetate. In addition small areas were planted in beans. The terraces of both the first and second zones are temporal. (Map 8, Area 2)

The third zone of terraces includes a number of separate systems in various stages of construction and preservation. The zone includes the area below Cerros Aguatepec, Tezqueme and Tlacuache Grande. It reaches below the village to the Barranca Tecorral. The terraces form part of the terrace system belonging to Colhuacan. They are located on the west side of the Barranca de San Cristobal on the same ridge as the village of Maquixco Alto and probably date from pre-Conquest times. I have indicated this area as 3A in Map 8. It contains the best maintained terraces of Maquixco Alto with deep soils and good maize yields. Data on maize and soil classification are for the most part lacking for this area. It is probable that a number of terraces should be classified as tierra de humedad. Precise data suggest that two of the total of 52 hectares were planted in six month maize, 12 hectares in barley, three hectares in pasture with maguey, two are eroded tepetate, and the remaining 33 hectares were in four month maize.

Outside of this system but still within the third zone there is a second terrace system. It is located to the southwest and appears to have been constructed much more recently than the first system. It is part of an attempt

to reclaim the eroded tepetate ridge below Cerro Tezqueme. There are about twenty-five hectares of terraces within the system. I have indicated this area as 3B in Map 8. The terraces have brought the erosion on the lower part of the ridge under control although the upper part (not included here) is bare tepetate and steep hillslope. The soil in most of the terraces is not very deep. Six month maize was planted in two hectares, four month maize in two hectares and barley in eleven hectares, with seven hectares being pasture and three being eroded tepetate.

The third system of terraces within this zone lies below Cerro Tlacuache Grande, on the southwest side of the Barranca de Allacal. The system continues into the adjacent ejido lands. Within the pequena propiedad there are sixteen hectares of terraces. In the upper (southern) section some of the terraces have been destroyed by erosion but many still possess deep well-watered soil. Ten hectares were planted in barley, three hectares in maize, with one hectare of tepetate and two hectares of pasture. Data on maize type are not available. (Area 3C)

The fourth zone of terracing lies to the west of the village around the base of Cerro Tiquimil. The area is badly eroded but terracing has reclaimed some of it for agriculture. The zone contains forty-eight hectares of surface area. About twelve hectares are still bare tepetate. Many of the fields have very thin soil and most of the zone is temporal. Thirteen hectares were planted in maize, eighteen hectares in barley, with five hectares of pasture and maguey. (4)

In the last decade the houselots of the village have become important sites for the raising of nopal. Maguey also occurs on houselots. This area includes about fifteen hectares.

On the north side of the Barranca Tecorral, between the two zones of terraces, there is a relatively flat area of thirty-nine hectares, excluding the presas. The area is badly eroded, with eighteen hectares of bare tepetate. Thirteen hectares were in pasture, six hectares in barley and two hectares in four month maize.

The other area of private property is located within the lands of Teacalco. It is on the ridge top below Cerro Tiquimil and consists of about thirty-two hectares of thin soil, with maguey bancals present. The area is referred to as the Rancho de Tenango and is owned by one family in Maquixco Alto. I have no data on the crops planted in the area (Area 4 on the map).

The other areas within the pequena propiedad of Maquixco Alto are eroded tepetate and steep or medium hillslopes used to grow maguey or to serve as pasture.

Out of the total 348 hectares of pequena propiedad of Maquixco Alto (excluding the thirty-two hectares of the Rancho de Tenango) 137 hectares were planted in maize or barley. Of these, thirteen hectares were in six month maize, fifty-six hectares in four month maize, and sixty-eight hectares are in barley. It is possible that some of the fields indicated with four month maize should be reclassified as six month maize.

Using yields of 3000 kilograms of maize per hectare of tierra de humedad and 1500 kilograms per hectare of tierra de temporal the area planted in maize

would yield 123,000 kilograms of maize in a good year. This is enough to support a population of 615 persons, consuming 200 kilograms of maize per person each year. In a poor year, using yields of 1200 kilograms per hectare of tierra de humedad and 900 kilograms per hectare of tierra de temporal, the yield would drop to 65,900 kilograms, enough to support a population of only 328 individuals. Thus it appears that in Maquixco the growing of barley has made such great inroads into the pequena propiedad that the area no longer can provide maize for the population during bad years. Undoubtedly the ejido lands produce some maize, which would make up this apparent deficiency. However, it is equally clear that barley has become a very important crop, being planted in approximately 50% of the cultivated pequena propiedad. The emphasis on barley cultivation in Maquixco Alto is much greater than in Colhuacan.

Although I do not have detailed or complete data on the crop distribution and land classification within the ejido of Maquixco Alto I have indicated in Map 10-11 the pertinent available information. Barley is a major crop throughout the ejido lands with maize being grown in the deeper soil land. In the section of ejido near the Hacienda San Cayetano there is an area of seventy-three hectares which includes flat fields with deep soil and maguey bancals. The fields are planted in barley and maize and are classified as tierra de temporal. Below this area of deep soils there is a section of ejido belonging to Teacalco with bancal terracing and thin soils, also planted in maize and barley. Above the hacienda is a section with great areas of exposed tepetate, bancal terracing and fields with thin soils. The terrace system (3C) of the pequena propiedad continues into this area. There are sixteen hectares of terraces within the ejido. Soil depth in them is variable as are the crops.

Only eleven households (13.9%) in Maquixco Alto hold neither pequena propiedad nor ejido lands. Five households (6.3%) are supported by activities other than agricultural ones. The village economy is based on agriculture.

The campesinos of Maquixco Alto focus agricultural activities on the terraces and presas which are used to grow maize. Maguey and barley are grown as cash crops in peripheral agricultural lands. It is possible that both true and bancal terraces were once widely spread throughout the pequena propiedad of Maquixco Alto with only fragments remaining today.

The farmers of Maquixco and Colhuacan also use the large areas of undivided and undeveloped ejido as communal pasture lands for sheep and goats.

Agriculture Economy-Cerro Gordo-North Slope

Today, on the northern slope of Cerro Gordo the terraces are fragmented into a number of small self-contained systems. Some are new, others appear to be quite old, probably pre-Conquest. On the basis of their significance to the modern population it is reasonable to assume that terraces were more important in the past and probably served as soil and water conservation mechanisms throughout the entire north slope area. Many remains of abandoned or nearly destroyed terraces occur in uncultivated areas associated with Aztec house remains.

In Map 9 the area of intensive archaeological survey is indicated. It included the pequena propiedad of Colhuacan, most of that of Maquixco Alto, as well as some belonging to campesinos from Teacalco. The area also includes

some of the ejido lands of both Maquixco Alto and Teacalco. Of the 1160 hectares within the survey area about 160 are too steep for cultivation. It is probable that the remaining 1000 hectares were cultivated with stone and bancal type terraces before the Conquest. If the well-preserved fragment of old terraces at Colhuacan is a good example of terrace systems in the area, approximately 130 hectares within the survey area would have been tierra de humedad, the rest being tierra de temporal.

Assuming that this entire area was planted in maize which had yields comparable to those mentioned earlier, then in a good year a total of 1,695,000 kilograms of maize would be harvested. In a poor year the harvest would drop to 939,000 kilograms of maize. Thus a maximum population of 8,475 persons consuming 200 kilograms of maize per year could be supported in good years and a maximum population of 4,695 persons in poor years. This is based on the assumption of well-kept intensive terracing throughout the survey area. Reducing the area of maize cultivation with the cultivation of other crops, the probable pre-Conquest population would be between 4500 and 5000 persons within the survey area. This estimate is subject to the same qualifications mentioned earlier in connection with the population estimates in the Lower Valley permanent irrigation agricultural system.

Although terracing is potentially able to support relatively large populations in hillslope areas it is quite apparent that the modern terrace systems within the pequena propiedad are not adequate to support the present population in poor years. Some new terraces are under construction but in general population pressure on the land in this area is taken care of in other ways. Cash income to buy necessary food is produced through the raising of barley, maguey, sheep and goats in marginal agricultural lands. In addition some of the population is being absorbed into the unskilled labor force in Mexico City. With these factors operating it is very unlikely that many new terrace systems will be constructed in the Cerro Gordo-North Slope area.

CONCLUSION

I have described in detail modern agriculture in the Teotihuacan Valley and the north slope of Cerro Gordo. Modern agriculture is of interest not only because of the synthesis of aboriginal and Hispanic traits, but also because it relates man to an environmental situation which presents a number of problems. Through an examination of the modern agriculture of this area it is possible to come to an understanding of the nature of the interrelationships of man and his environment, both present and past. A thorough knowledge of modern agriculture can aid in clarifying the pre-Conquest history of this area.

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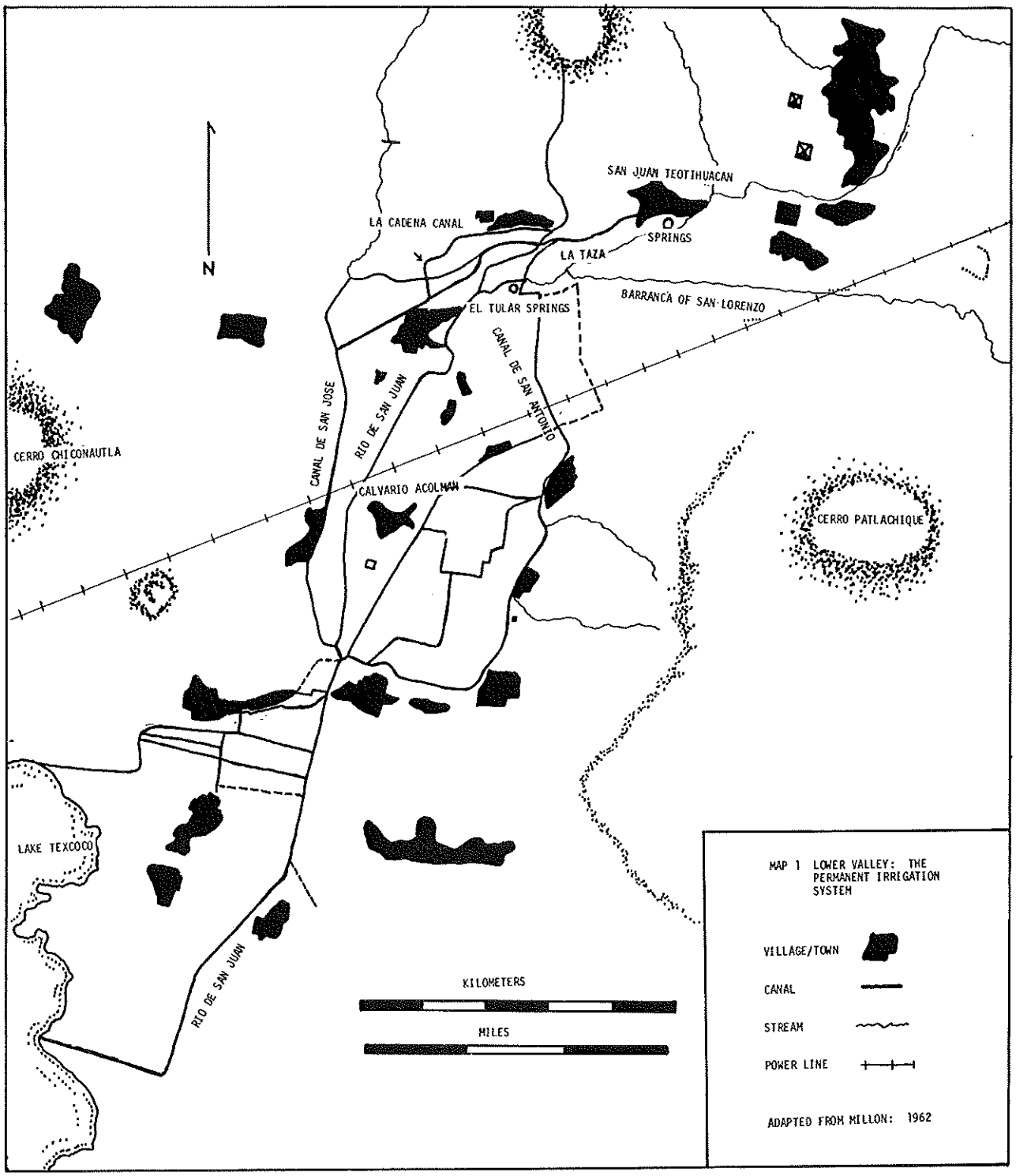

N
SAN JUAN TEOTIHUACAN
SPRINGS
LA CADENA CANAL
LA TAZA
EL TULAR SPRINGS
BARRANCA OF SAN LORENZO
CANAL DE SAN JOSE
RIO DE SAN JUAN
CANAL DE SAN ANTONIO
CERRO CHICONAUTLA
CALVARIO ACOLMAN
CERRO PATLACHIQUE
LAKE TEXCOCO
RIO DE SAN JUAN
KILOMETERS
MILES
MAP 1 LOWER VALLEY: THE PERMANENT IRRIGATION SYSTEM
VILLAGE/TOWN
CANAL
STREAM
POWER LINE
ADAPTED FROM MILLON: 1962

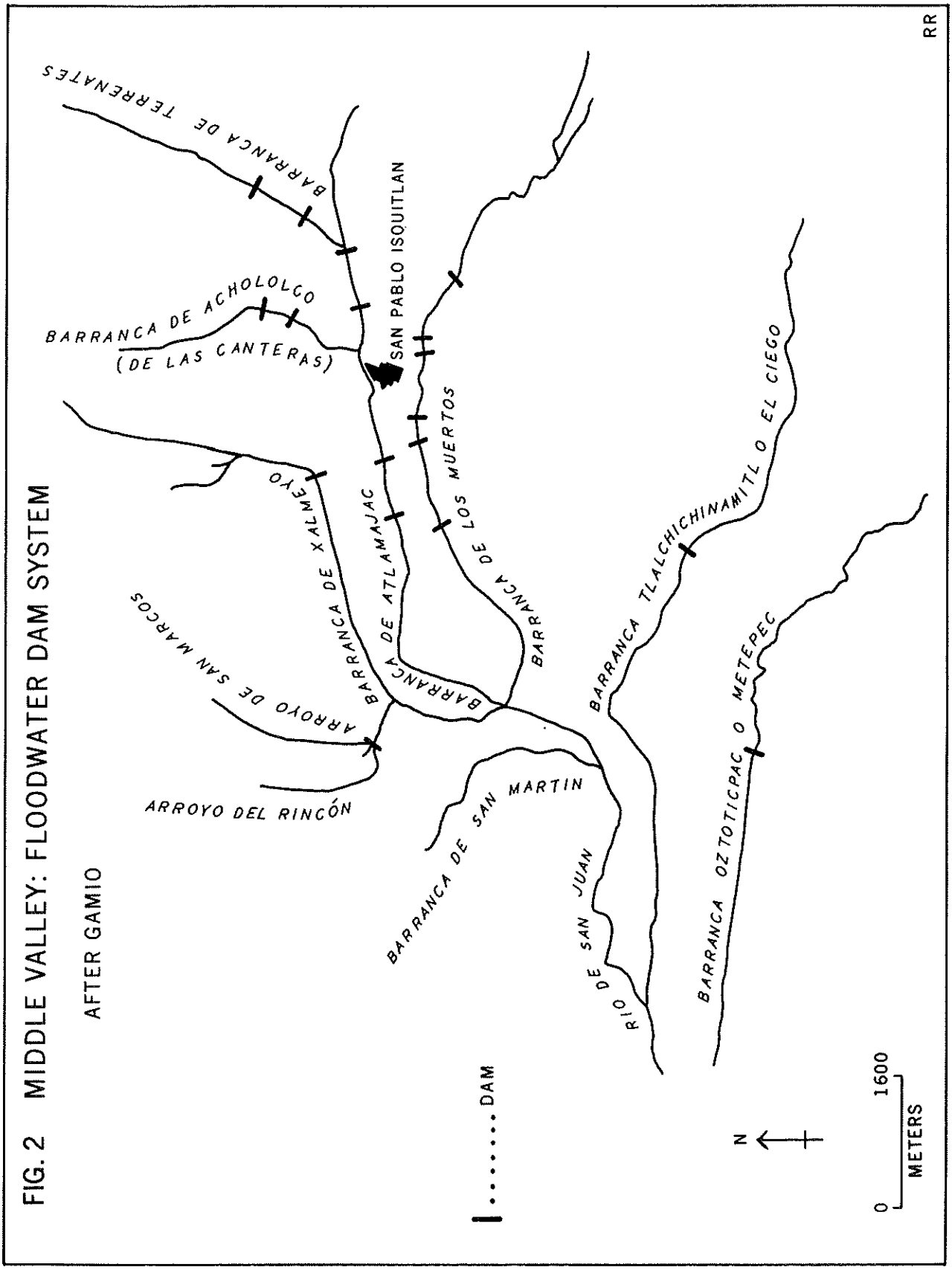
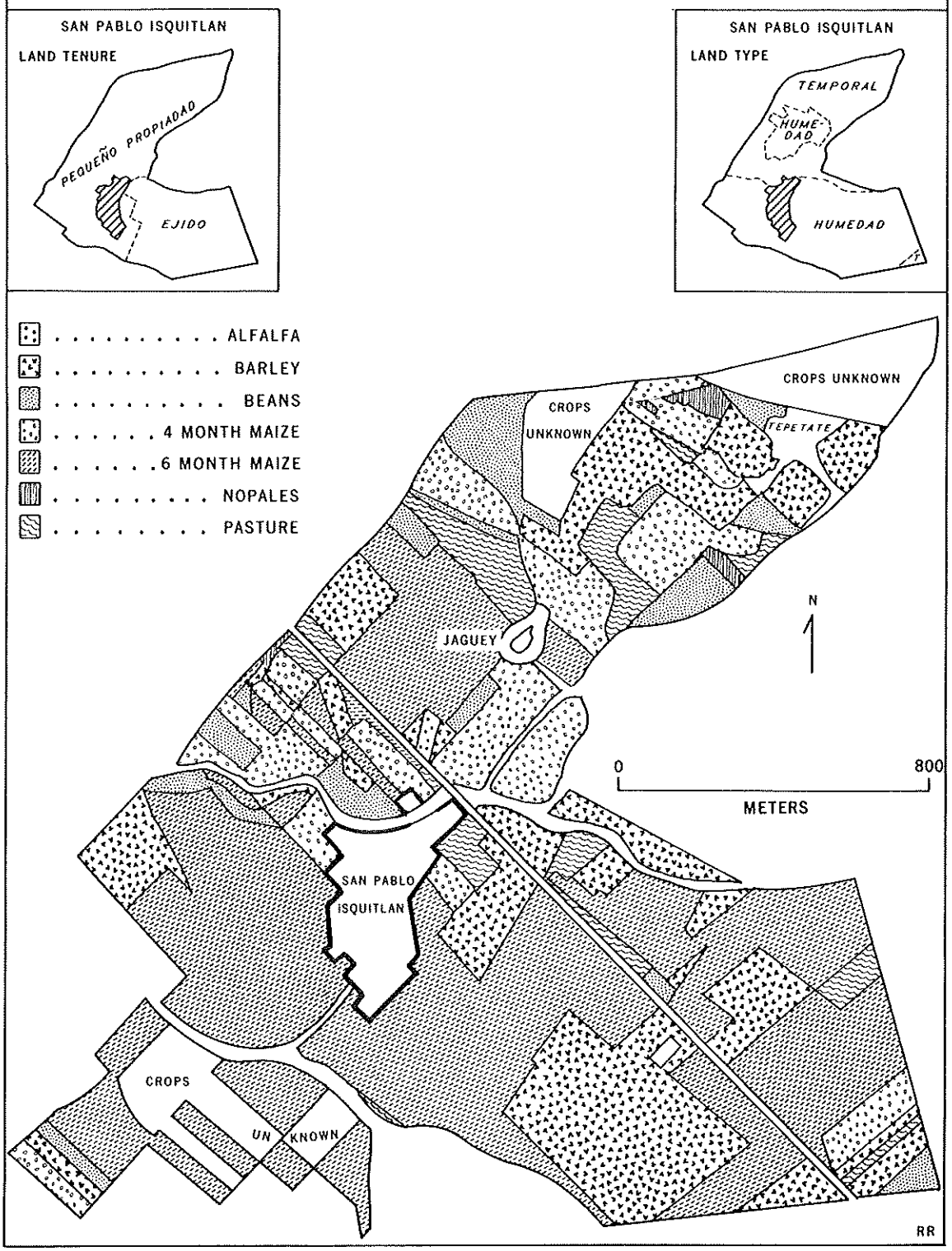


FIG. 2 MIDDLE VALLEY: FLOODWATER DAM SYSTEM

AFTER GAMIO

MAP 3

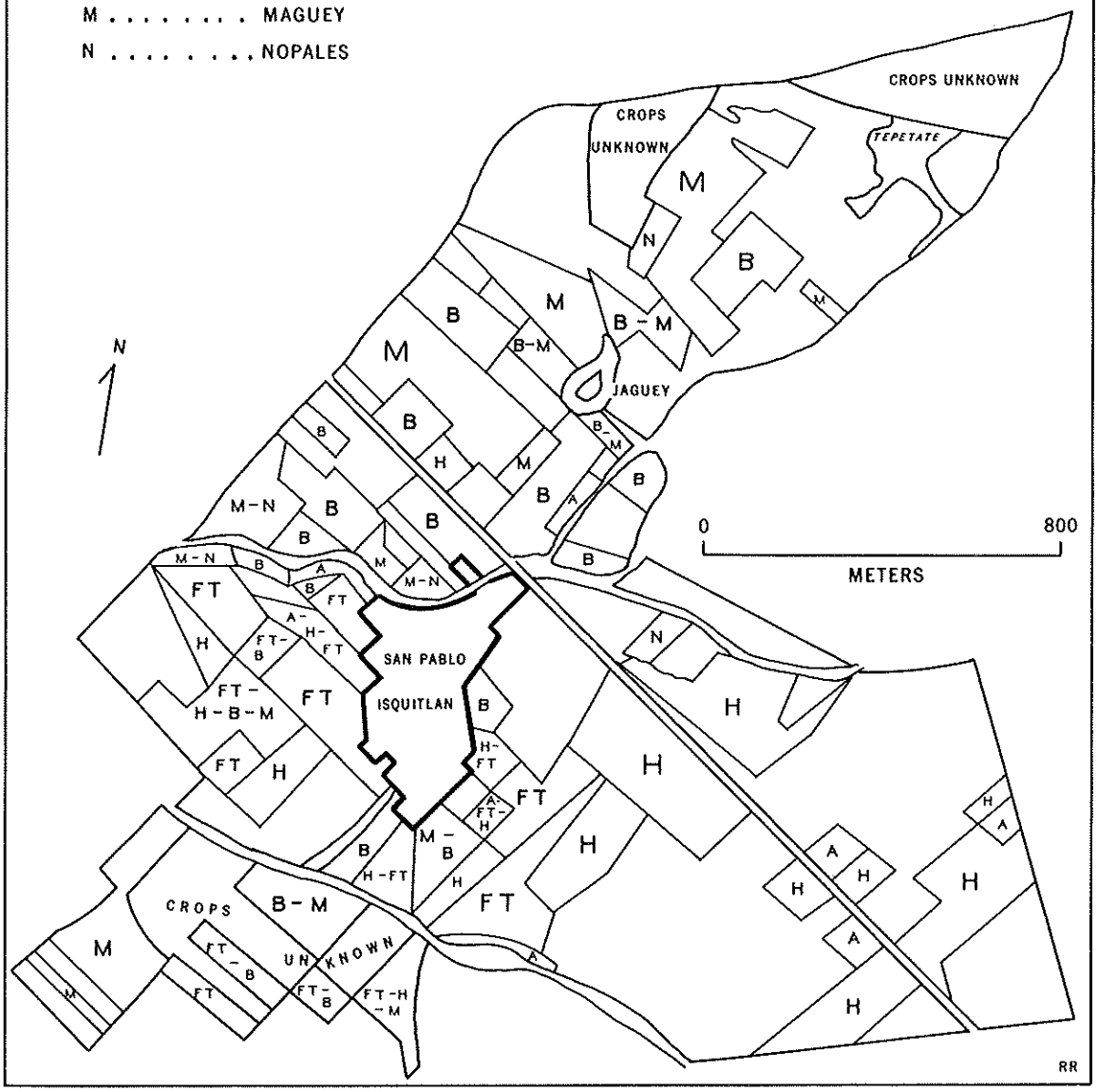
SAN PABLO ISQUITLAN: MAIN CROPS



MAP 4

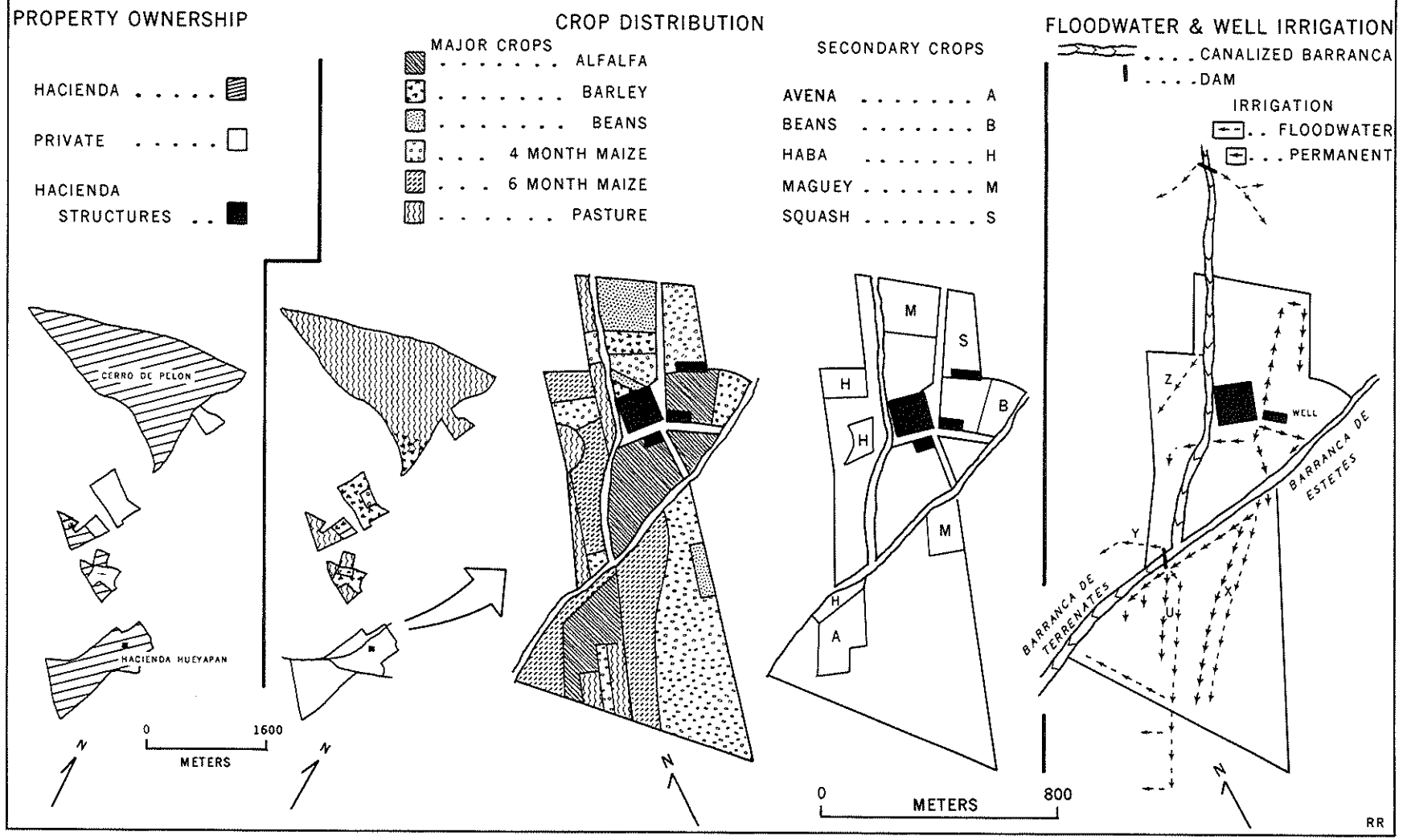
SAN PABLO ISQUITLAN: MINOR CROPS

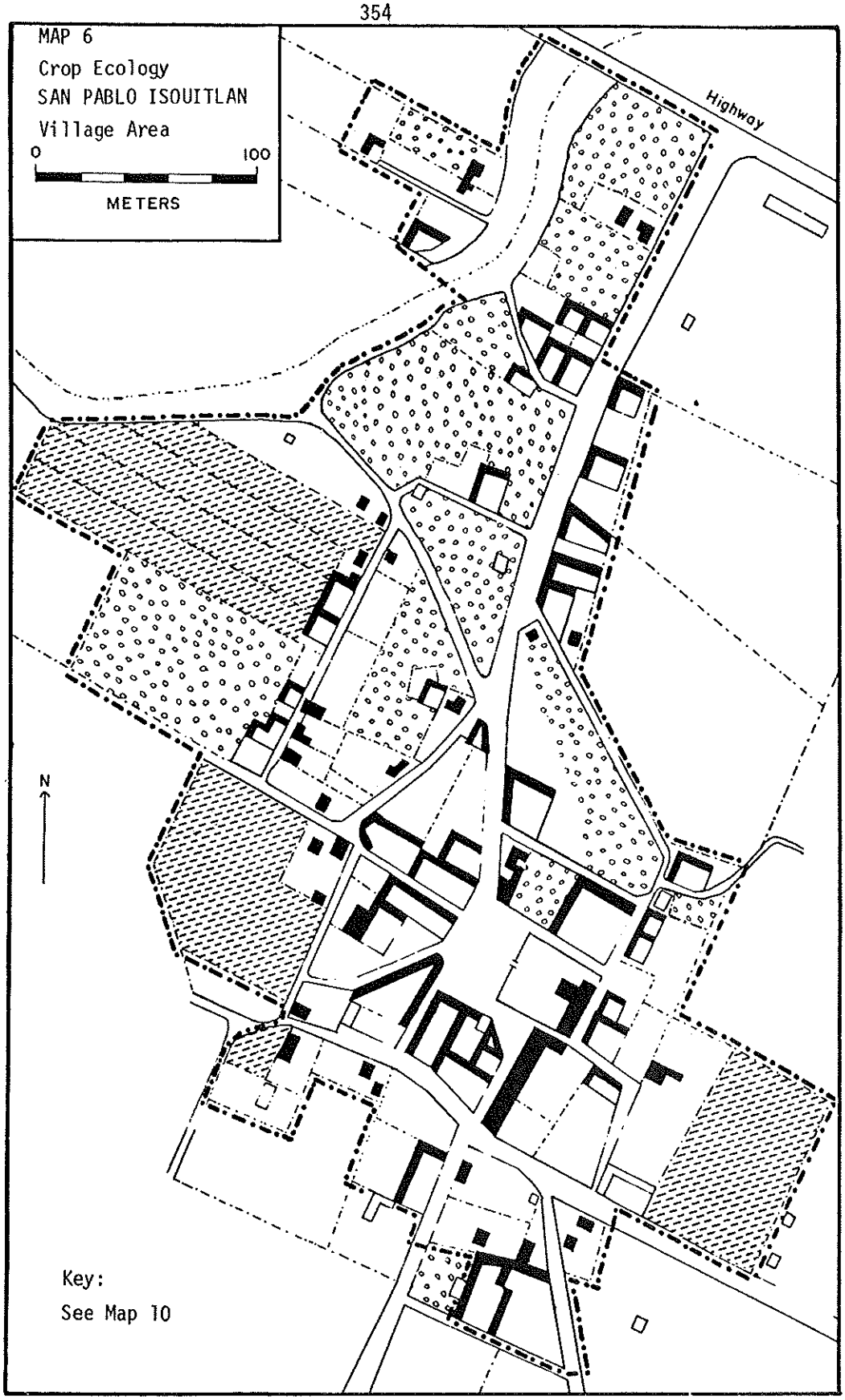
A . . . . . ALFALFA
B . . . . . BEANS
FT . . . . . FRUIT TREES
H . . . . . HABA
M . . . . . MAGUEY
N . . . . . NOPALES



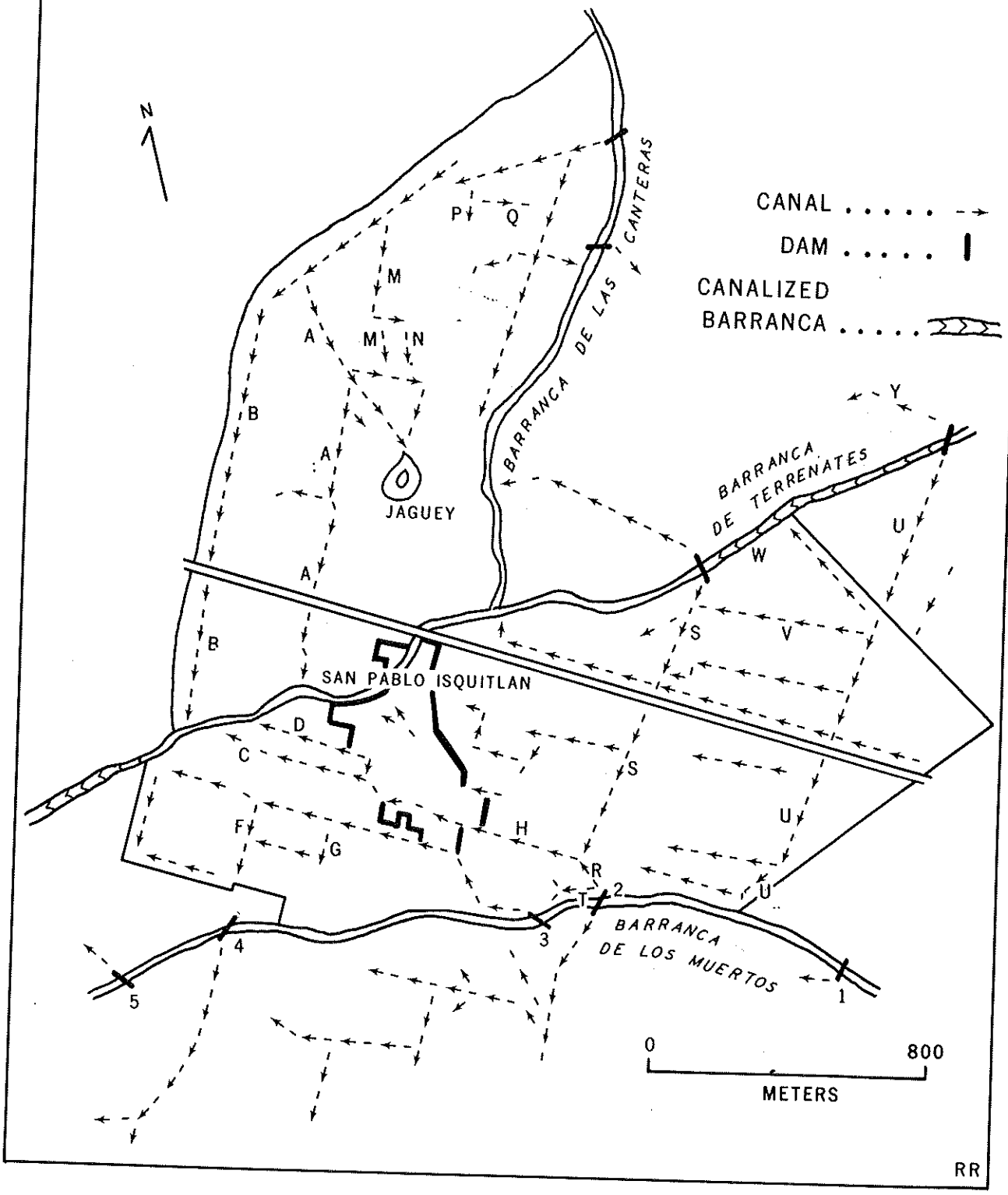
MAP 5

HILLSLOPE & HACIENDA HUEYAPAN (SAN PABLO ISQUITLAN)



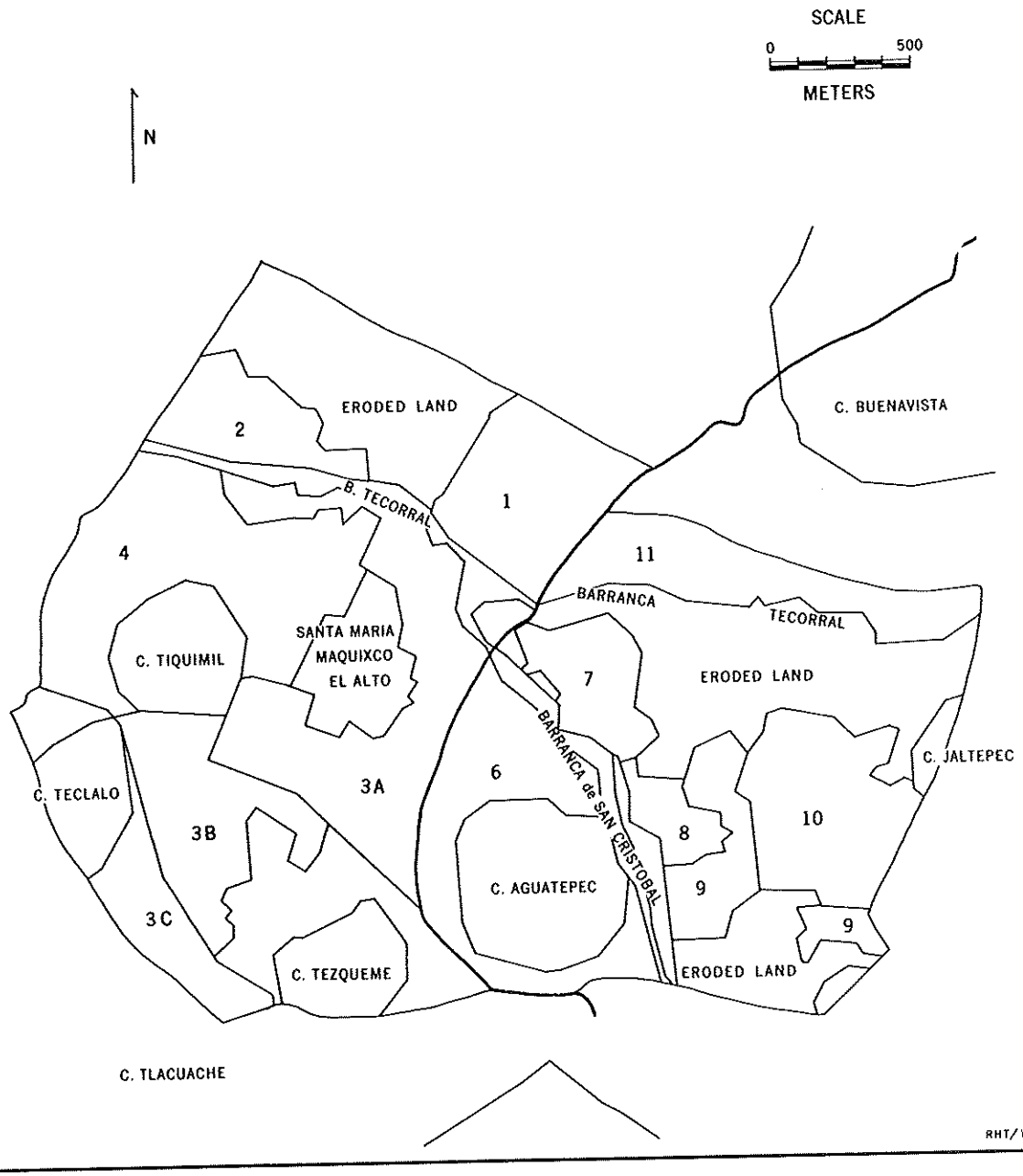

MAP 6
Crop Ecology
SAN PABLO ISOUITLAN
Village Area
0
100
METERS
Highway
N
Key:
See Map 10

MAP 7 SAN PABLO ISQUITLAN LANDHOLDINGS: FLOODWATER CANALS



MAP 8

CERRO GORDO NORTH SLOPE — TERRACE SYSTEM AND PRIVATE LANDS



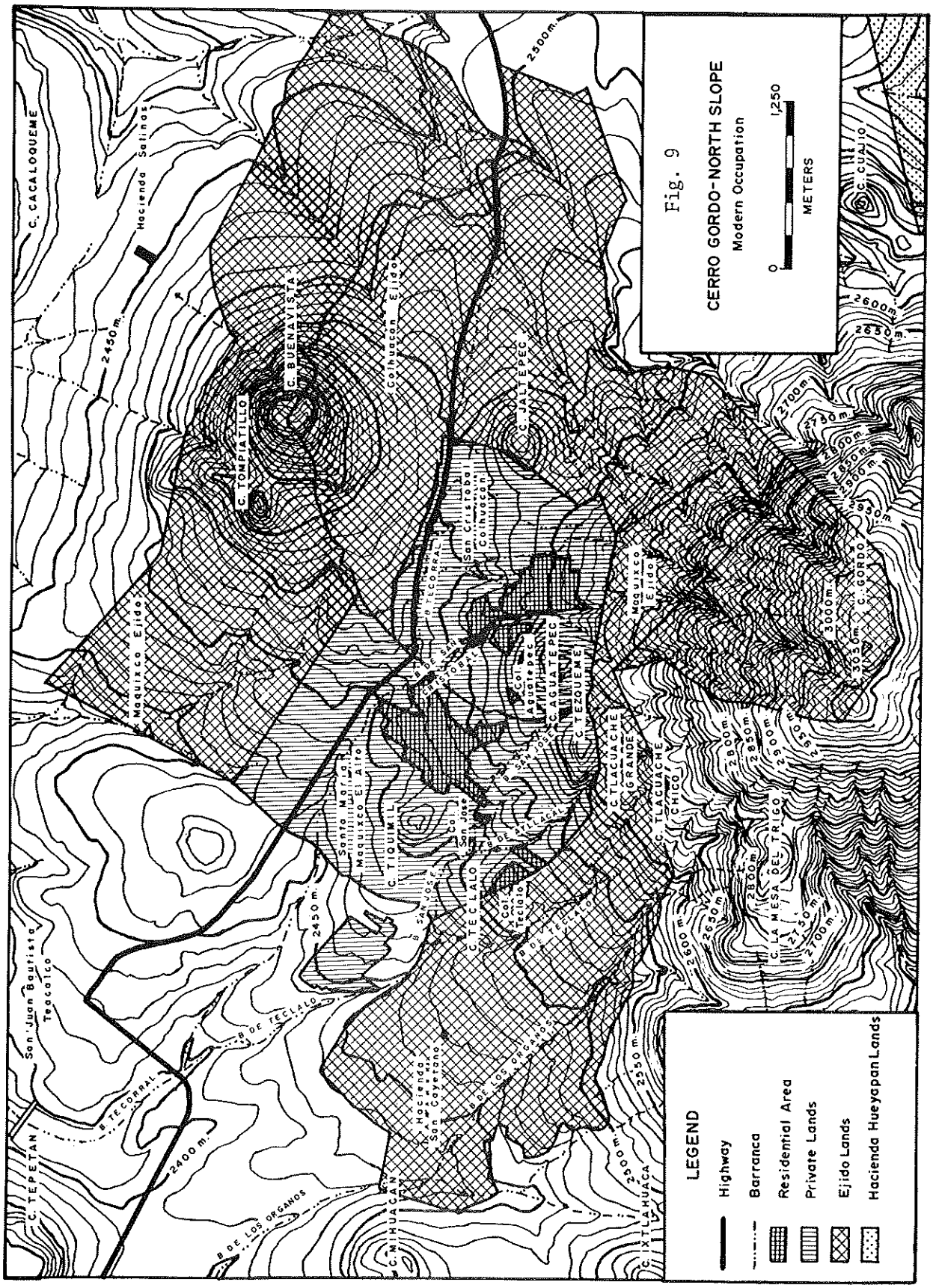
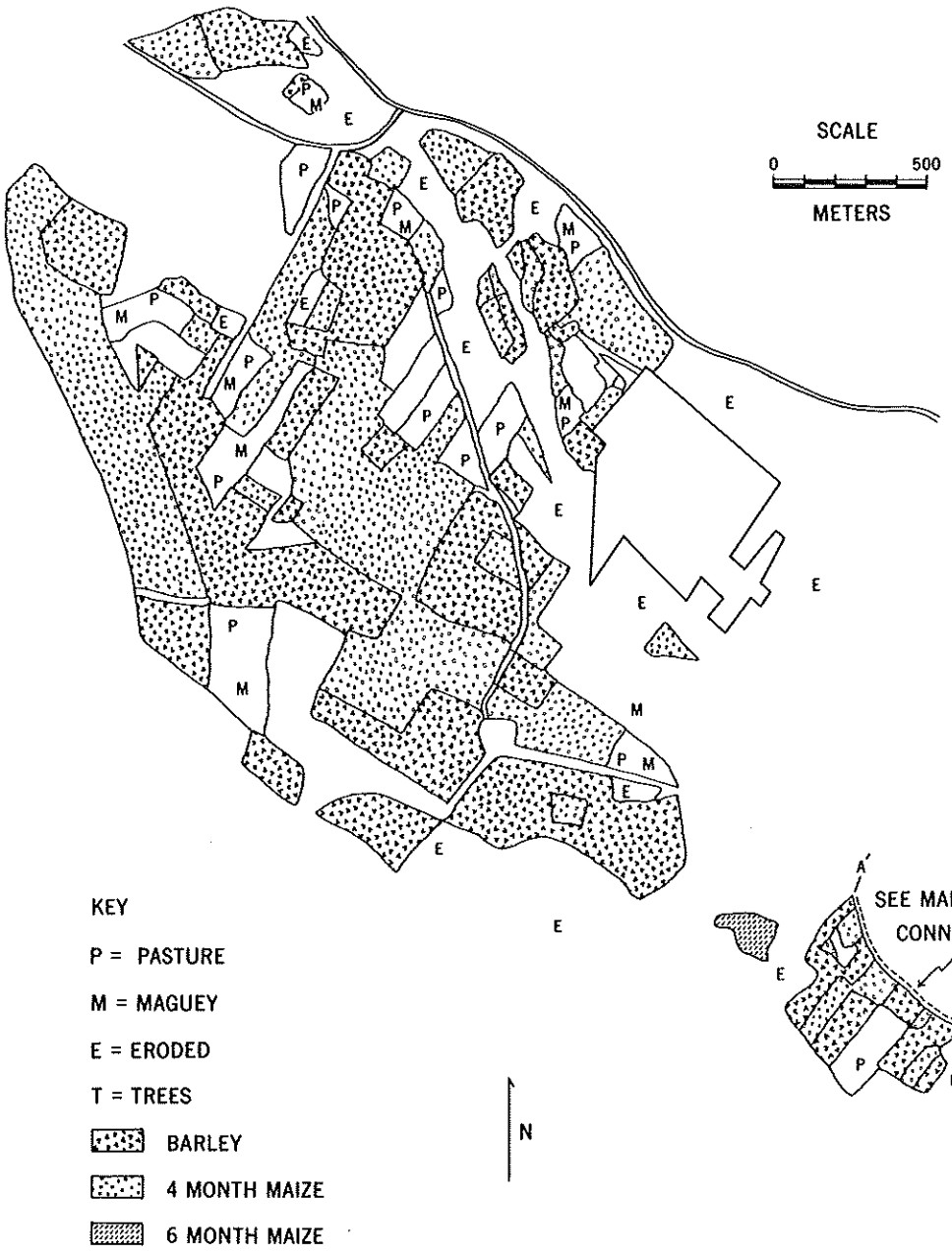

CERRO GORDO-NORTH SLOPE
Modern Occupation
0
1,250
METERS
LEGEND
Highway
Barranca
Residential Area
Private Lands
Ejido Lands
Hacienda Hueyapan Lands
C. CACALOQUEME
C. TEPETAN
C. TOMPIATILLO
C. BUENAVISTA
C. TIQUIMIL
C. TECLALO
C. TEZOQUEME
C. TLACUACHE GRANDE
C. TLACUACHE CHICO
C. LA MESA DEL TRIGO
C. GORDO
C. CUAJIO
C. JALTEPEC
C. MIHUACAN
C. IXTLAHUACA
Hacienda Salinas
Maquixco Ejido
Colhuacan Ejido
2450 m.
2400 m.
2350 m
2500 m.
2600 m.
2650 m.
2700 m.
2750 m.
2800 m.
2850 m.
2900 m.
2950 m.
3000 m.
3050 m.

Fig. 9



MAP 10

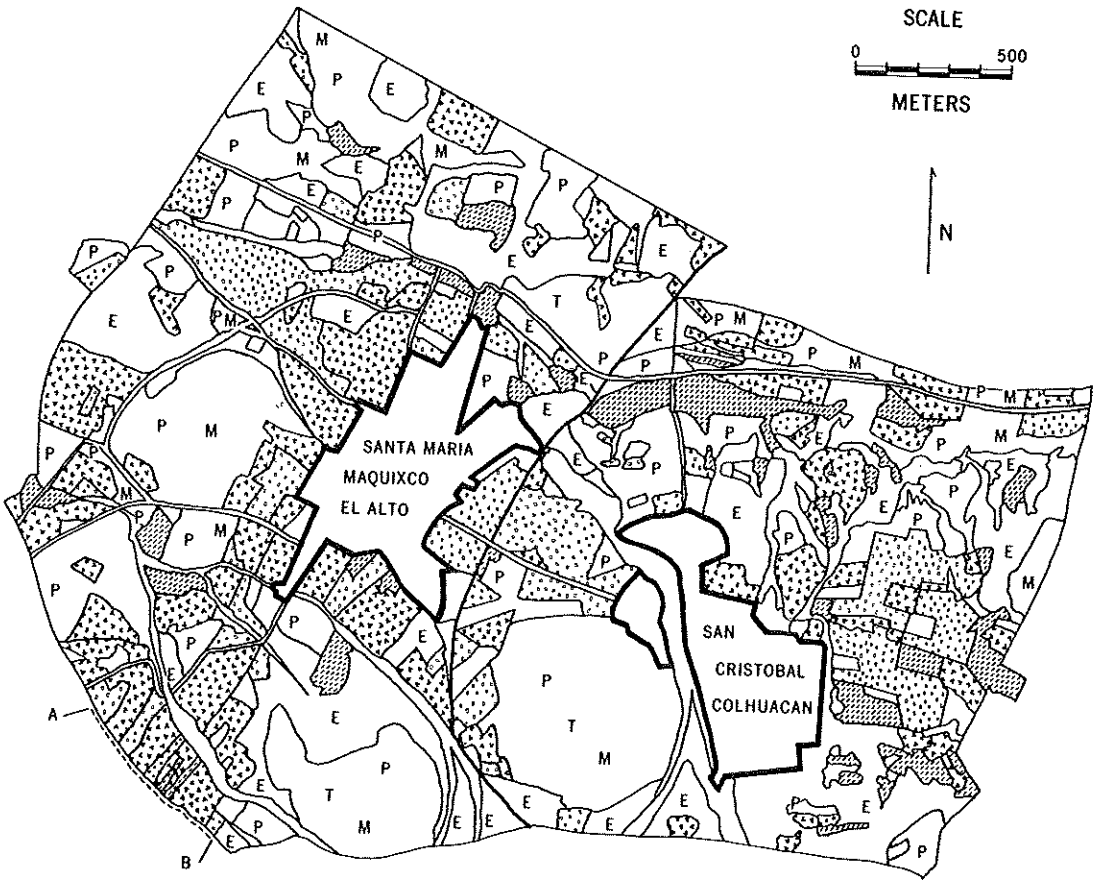
CERRO GORDO-CROP ECOLOGY

RHT/WHB

MAP 11

CERRO GORDO-CROP ECOLOGY

KEY: SEE MAP 10



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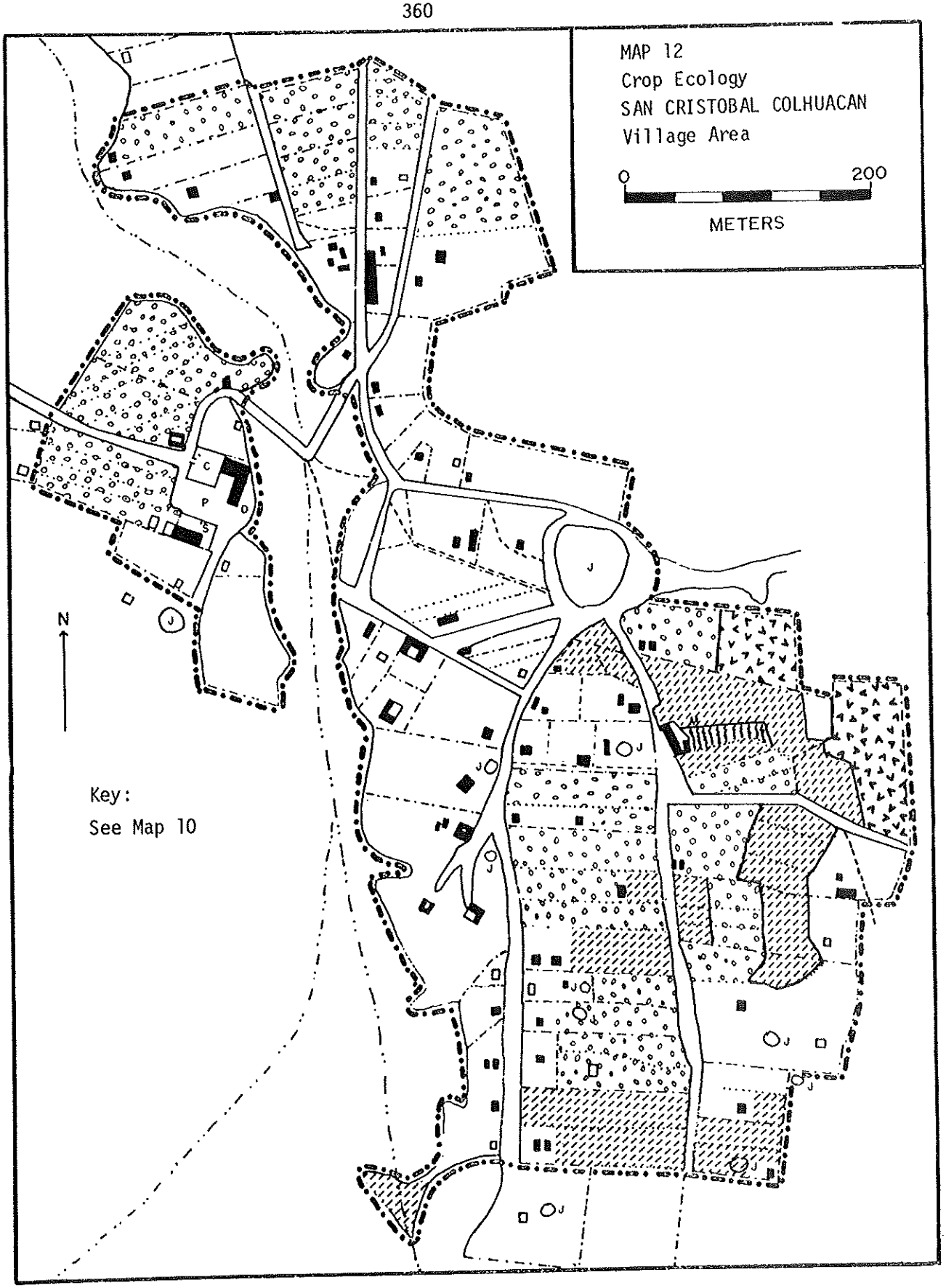
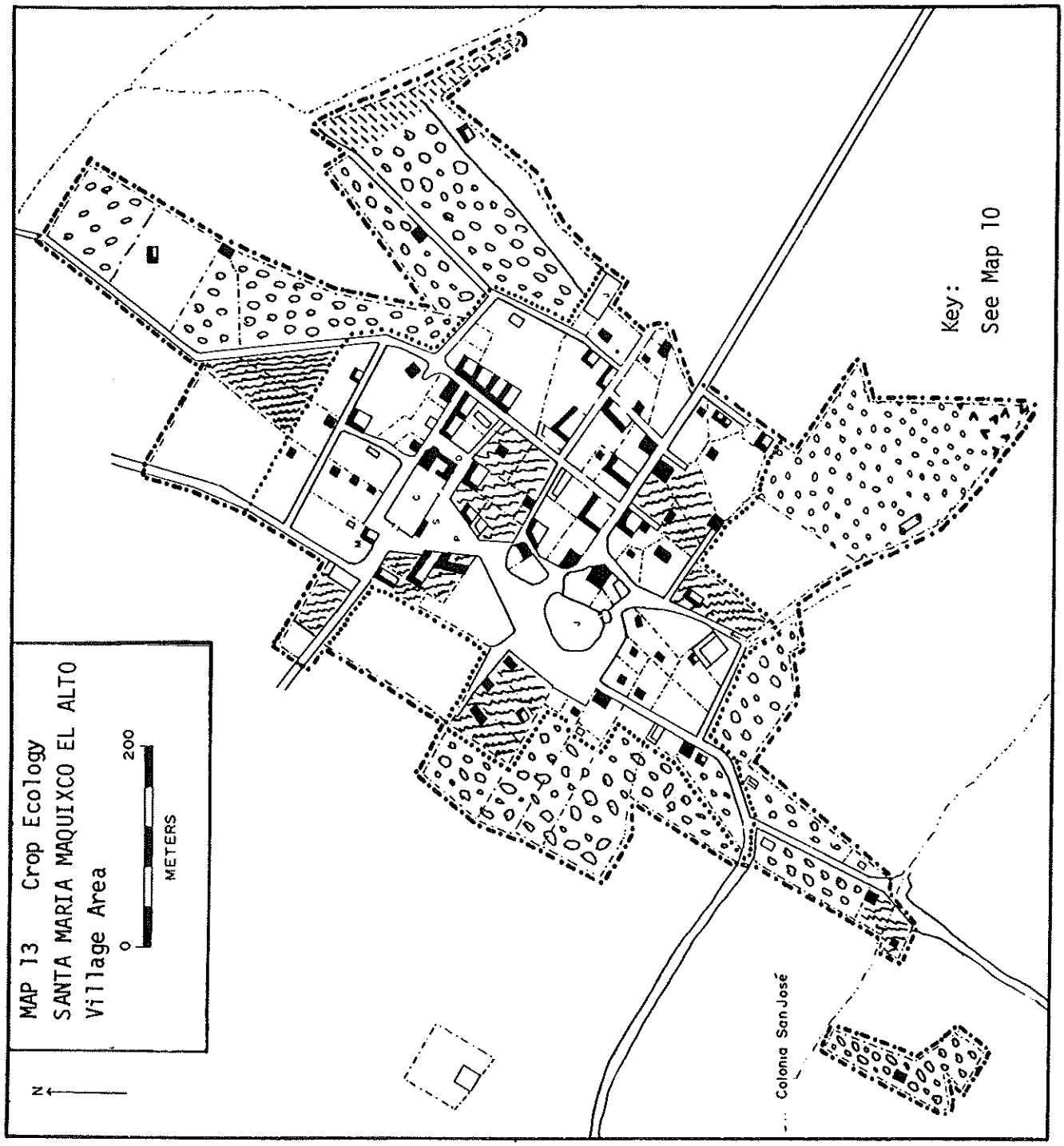
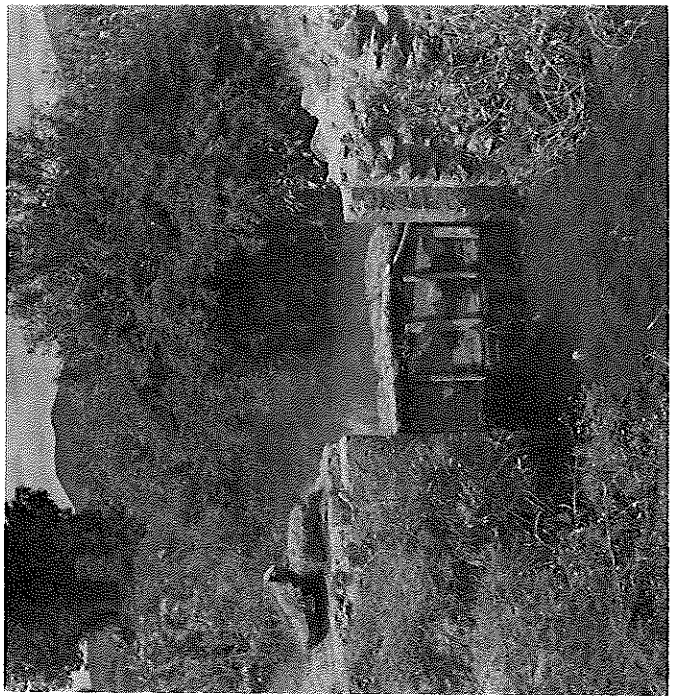
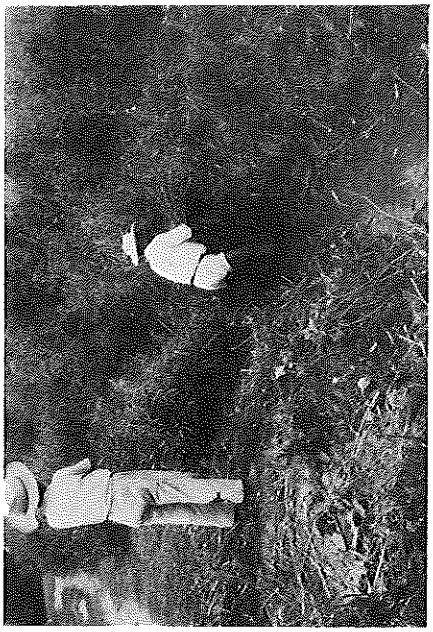
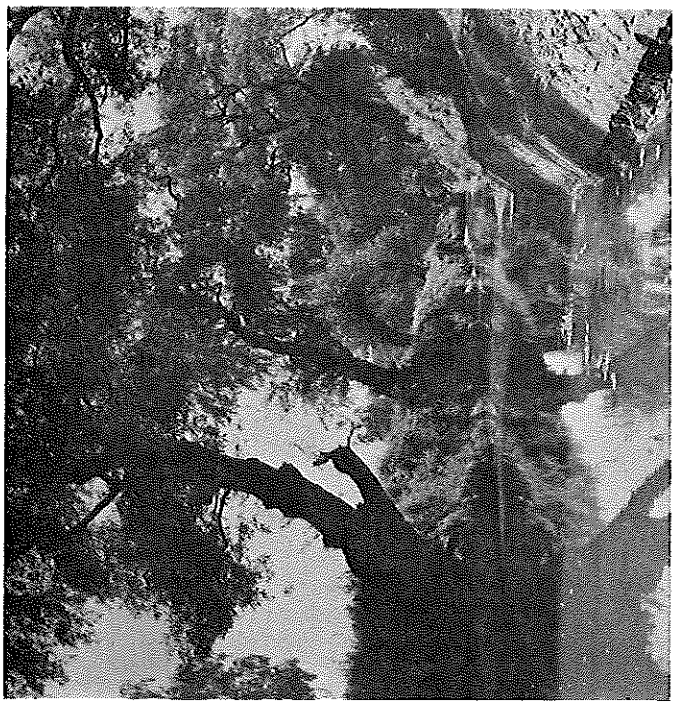

MAP 12
Crop Ecology
SAN CRISTOBAL COLHUACAN
Village Area
0
200
METERS
N
Key:
See Map 10


MAP 13 Crop Ecology
SANTA MARIA MAQUIXCO EL ALTO
Village Area
0
200
METERS
N
Key:
See Map 10
Colonia San José







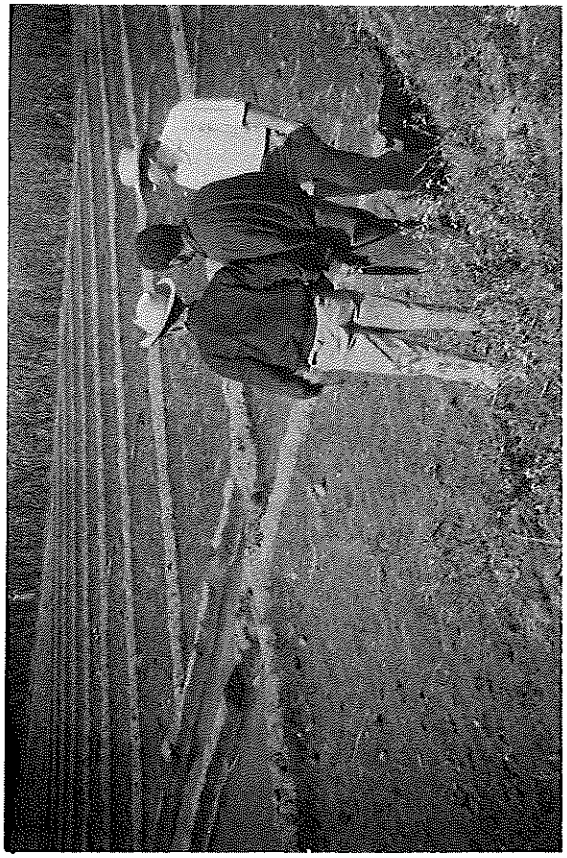
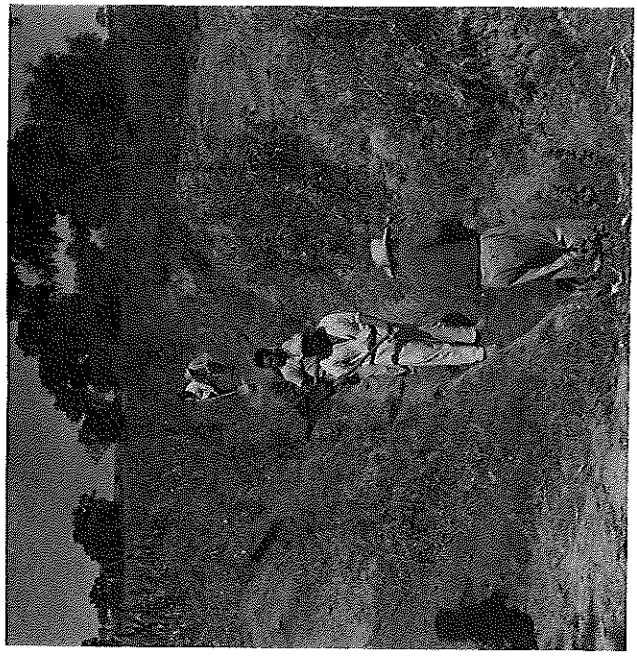
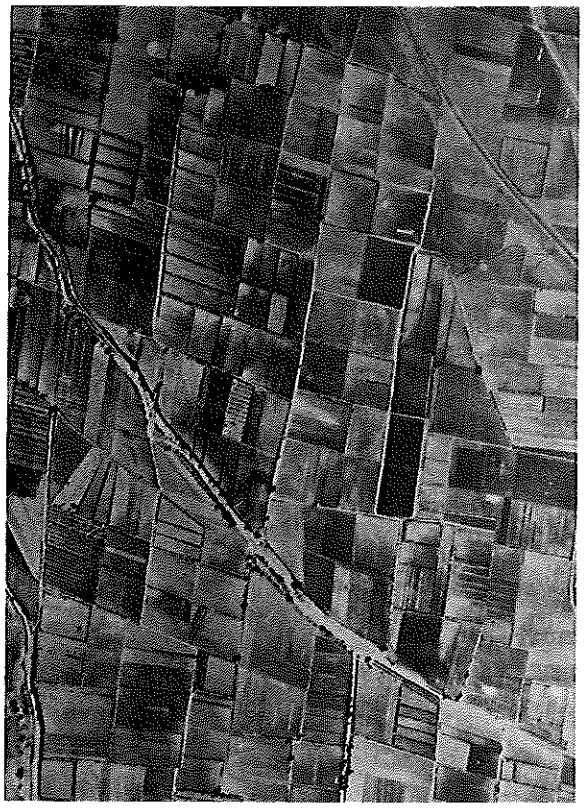
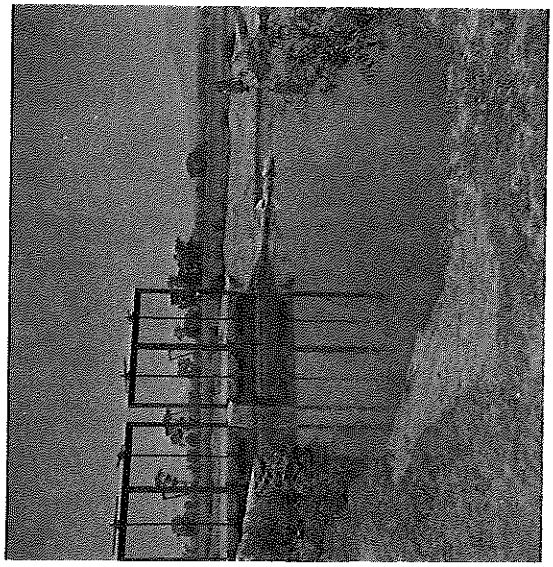
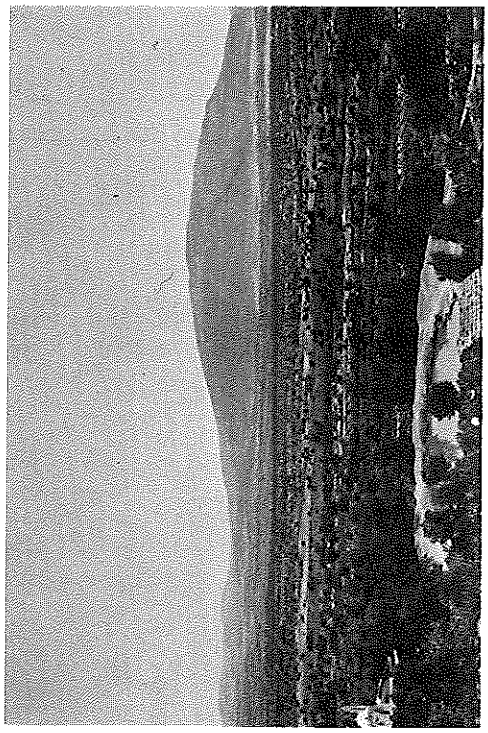


Plate 1









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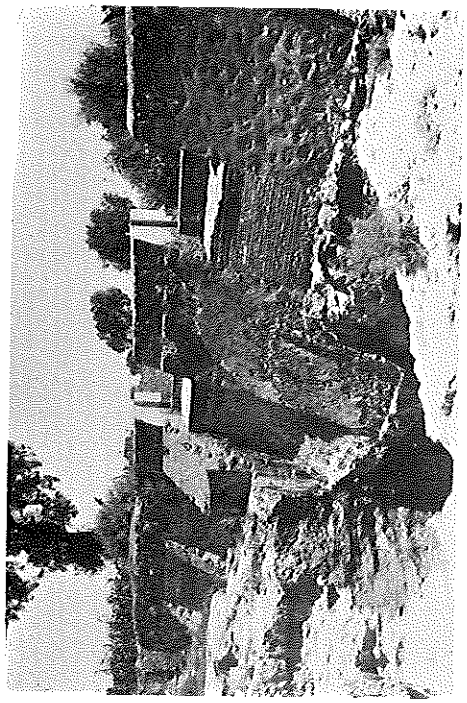

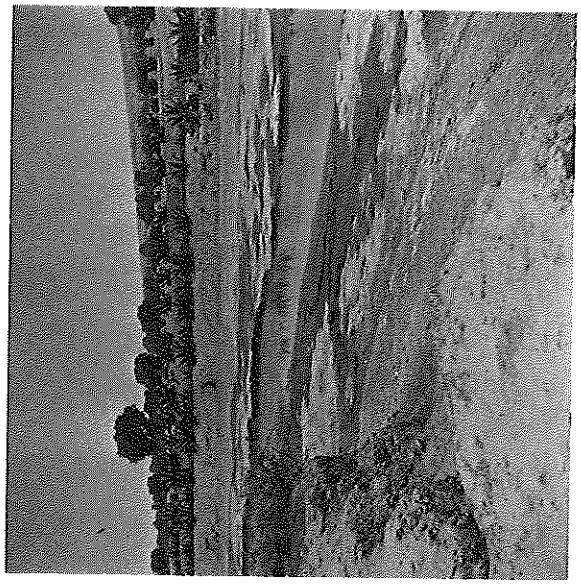

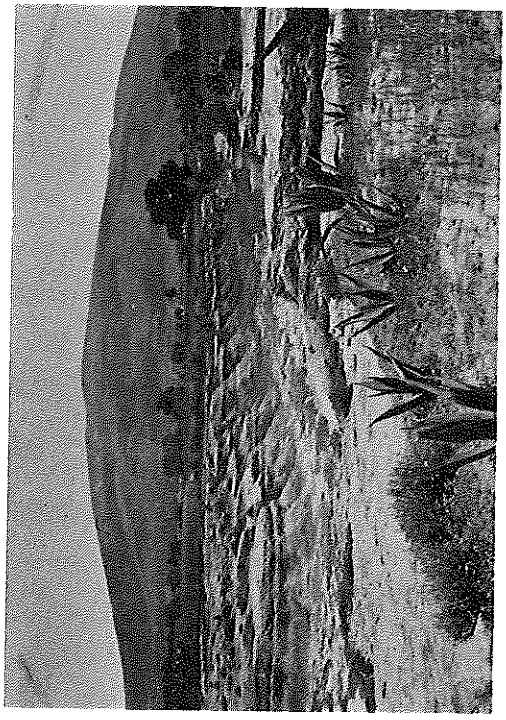

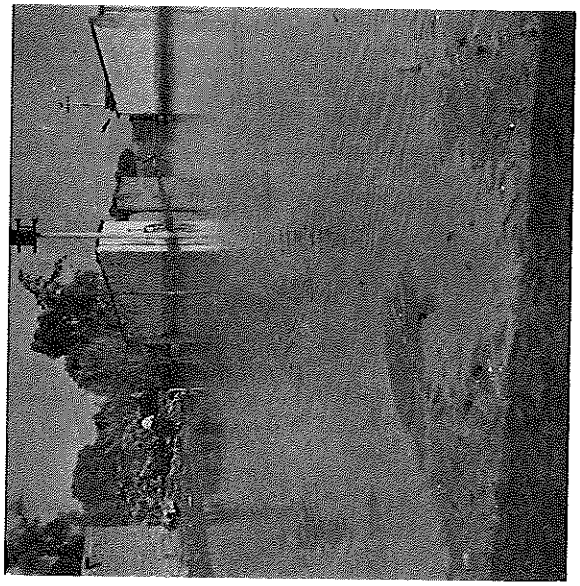

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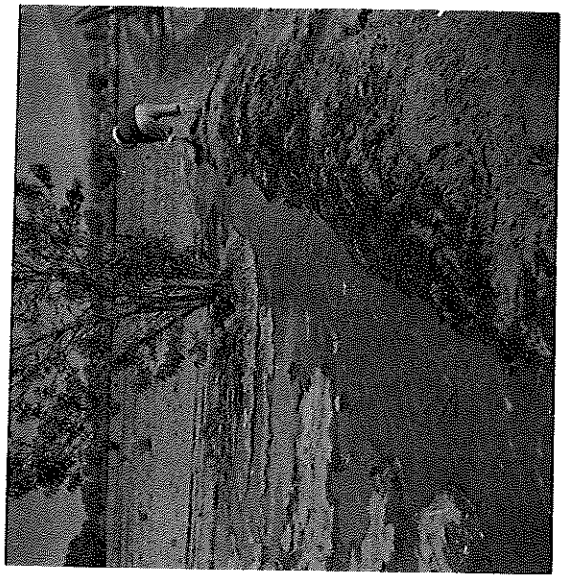

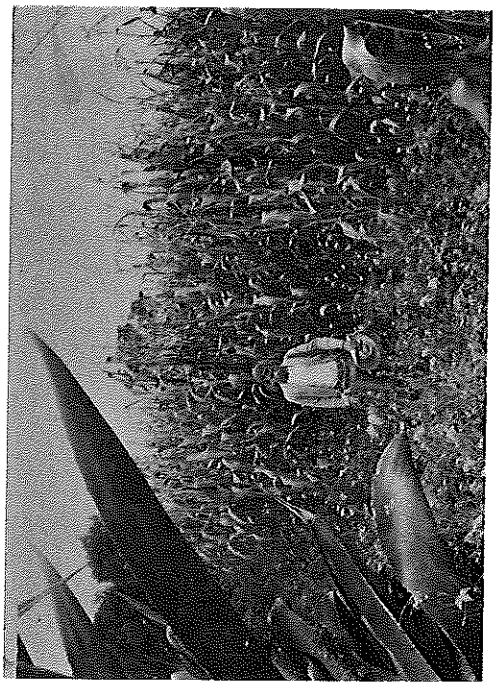

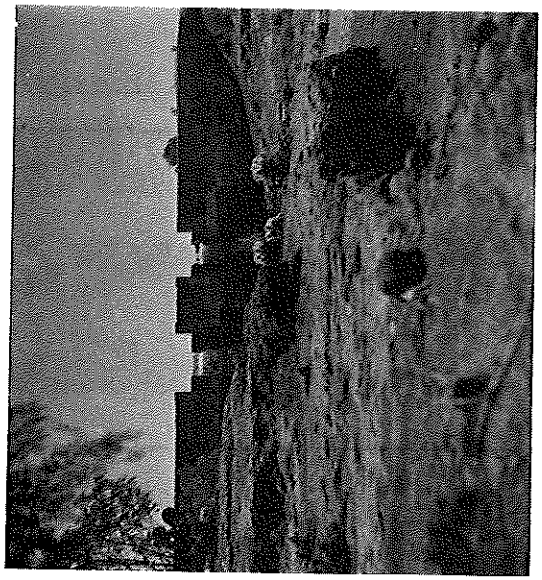

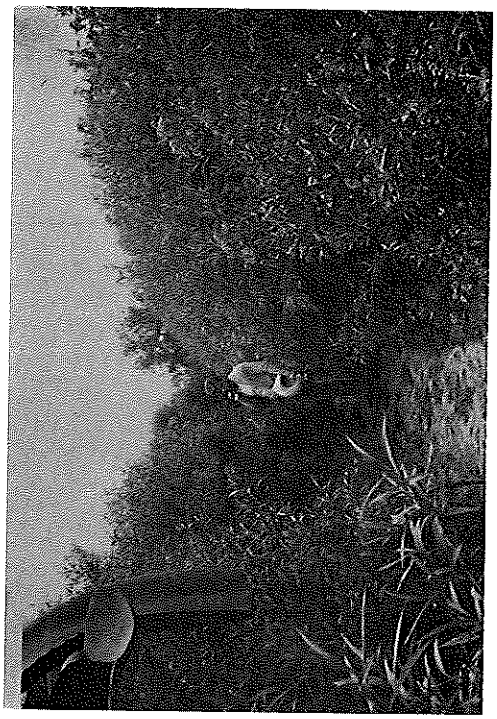

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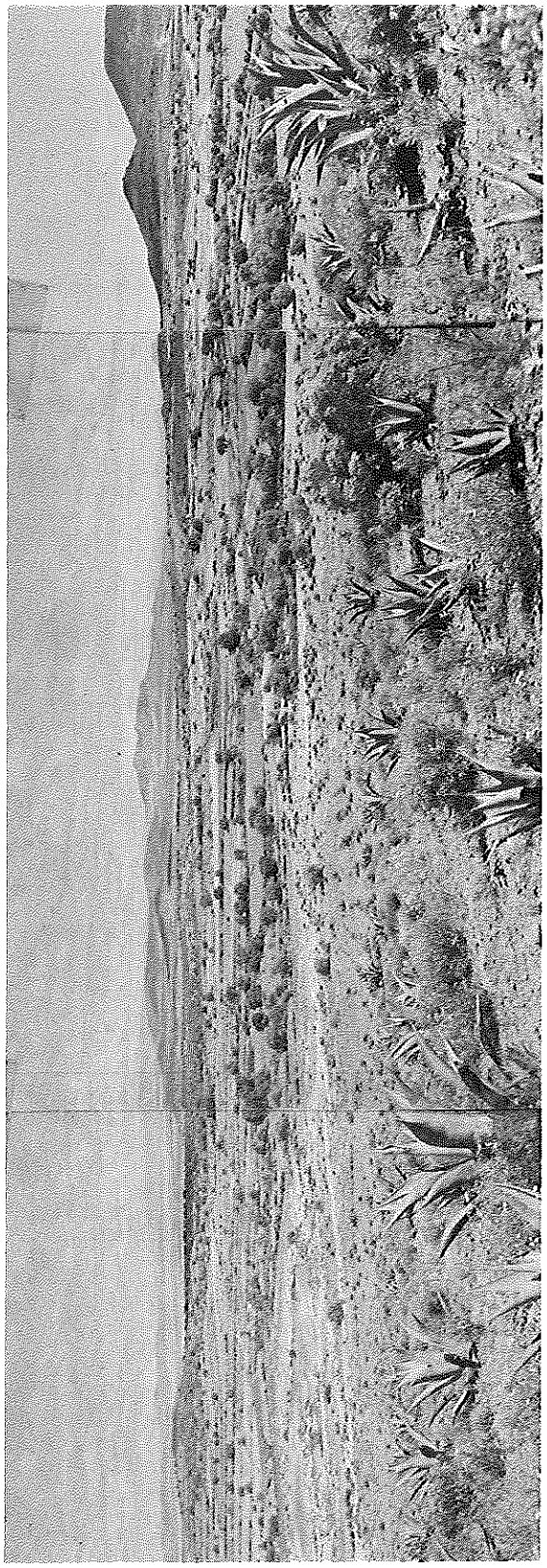

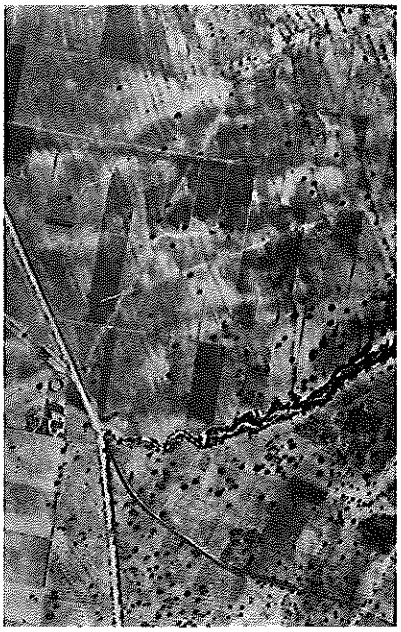

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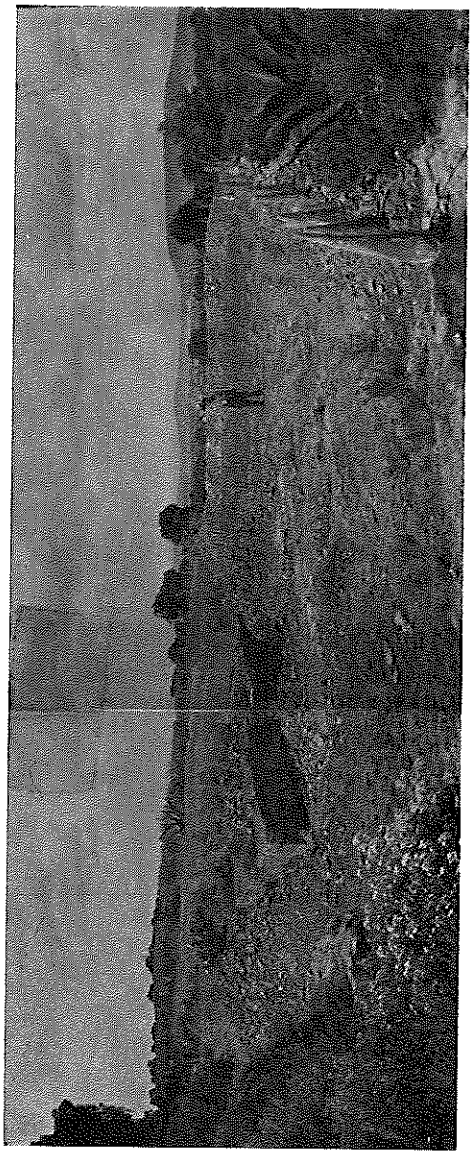

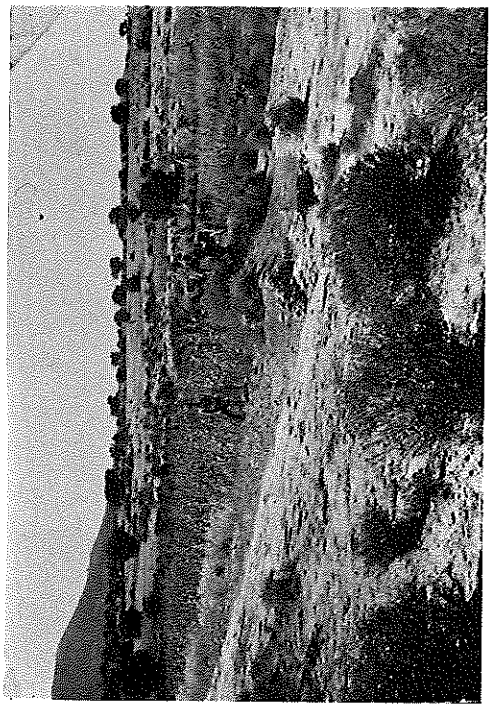

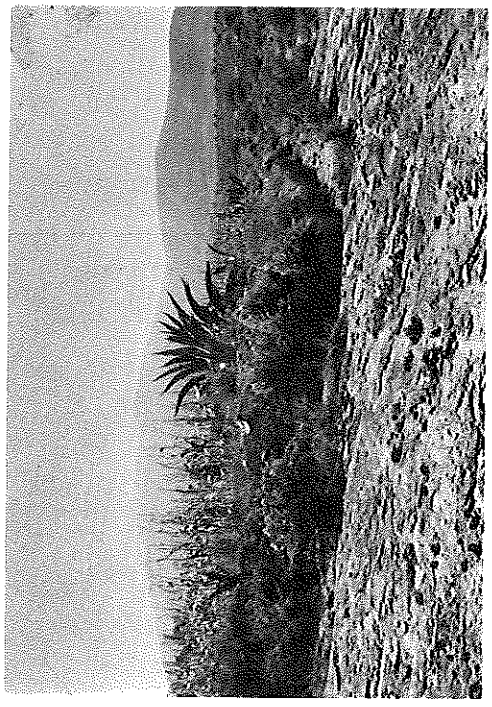

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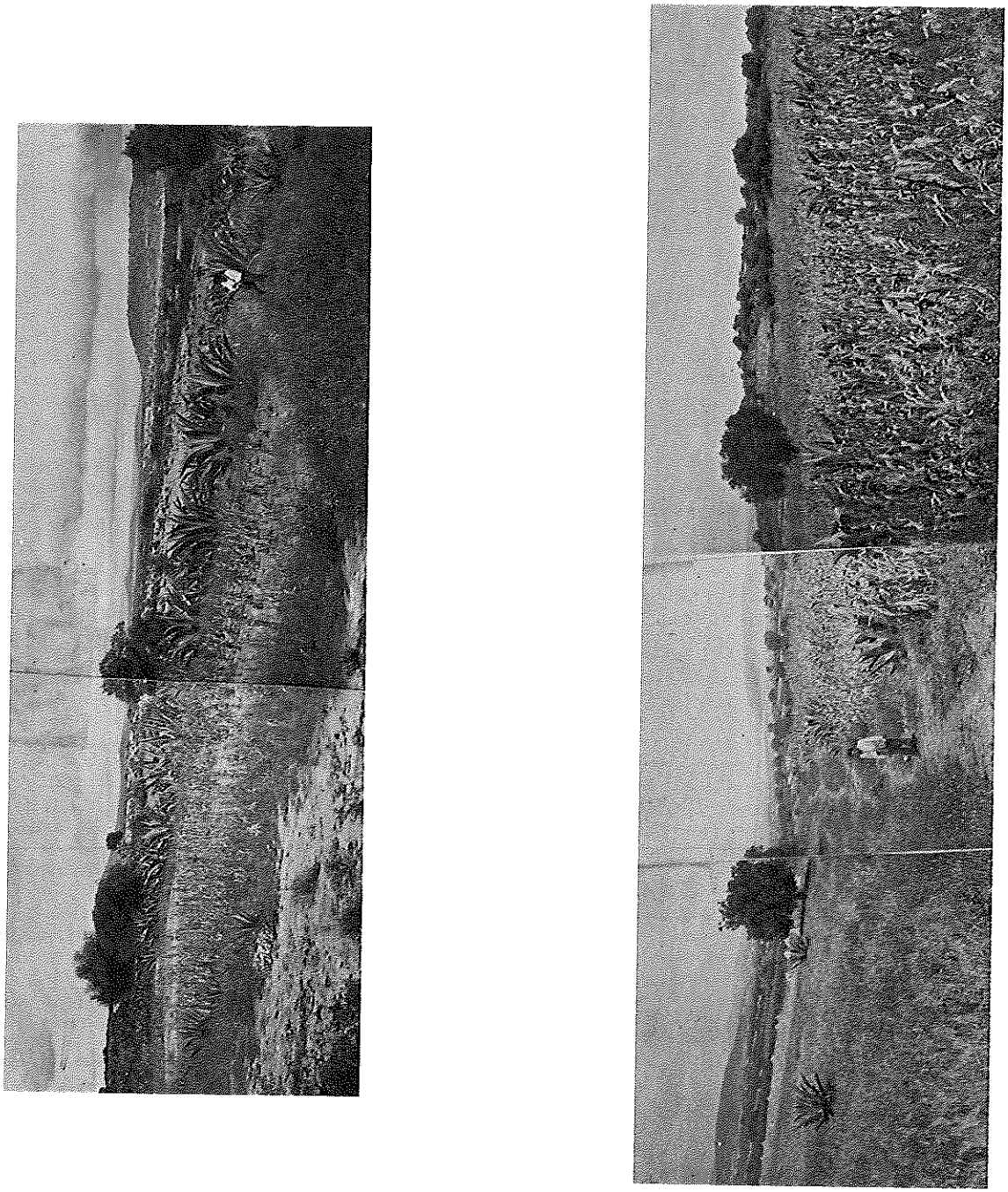

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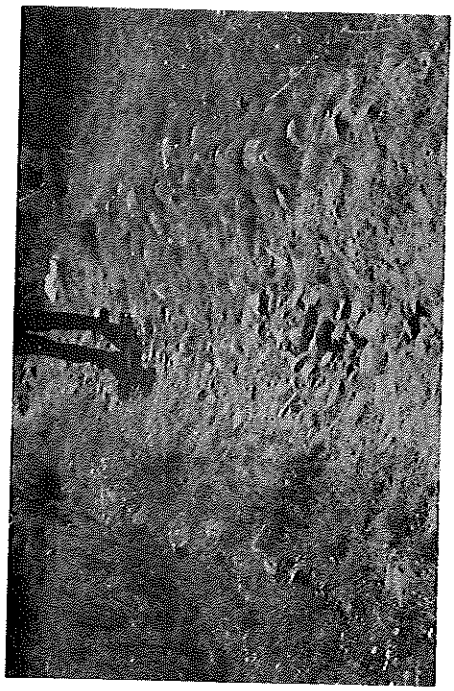

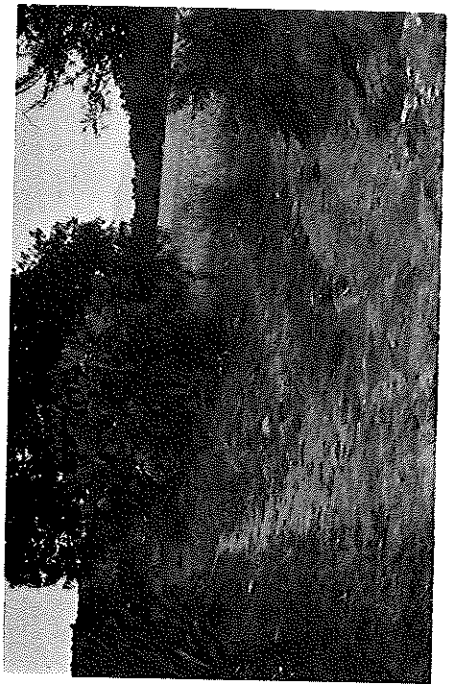

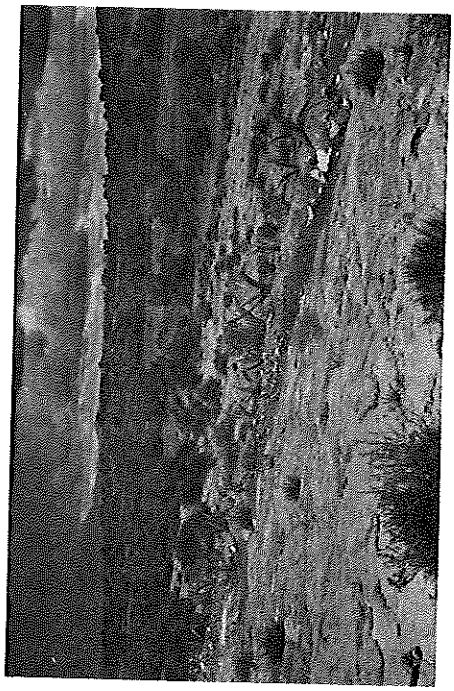

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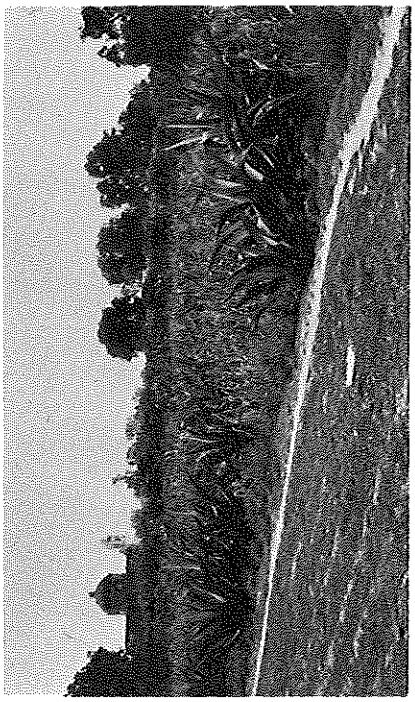

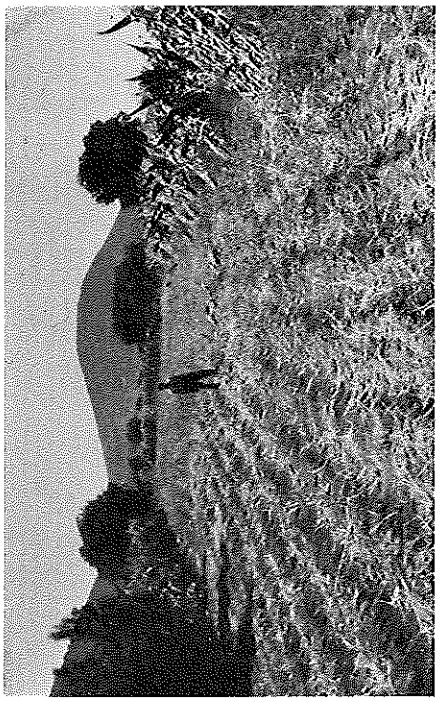

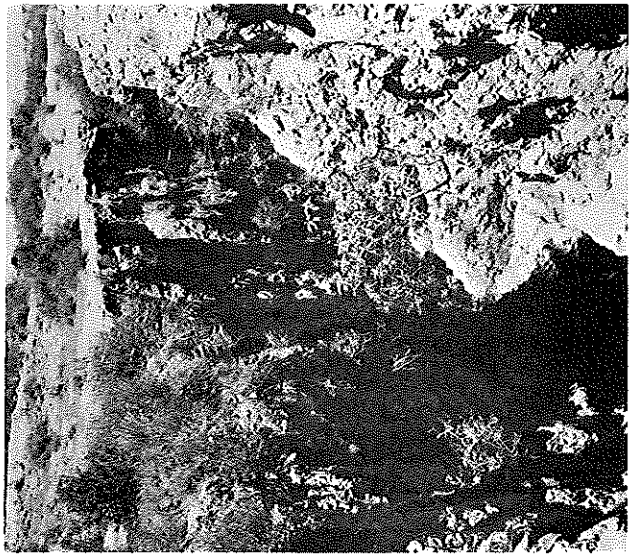

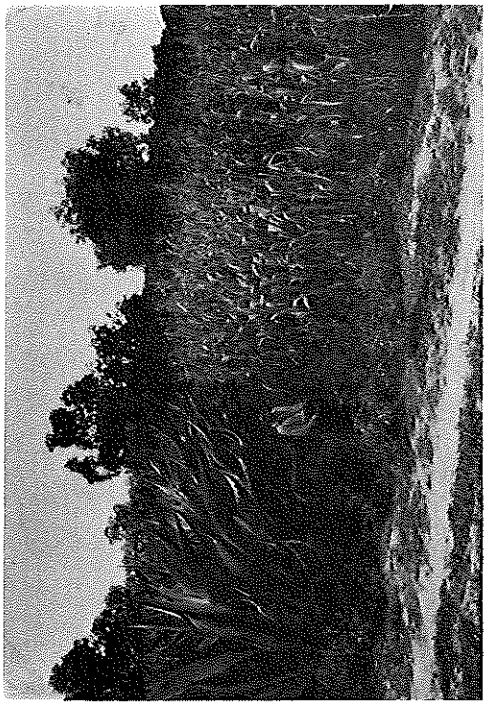

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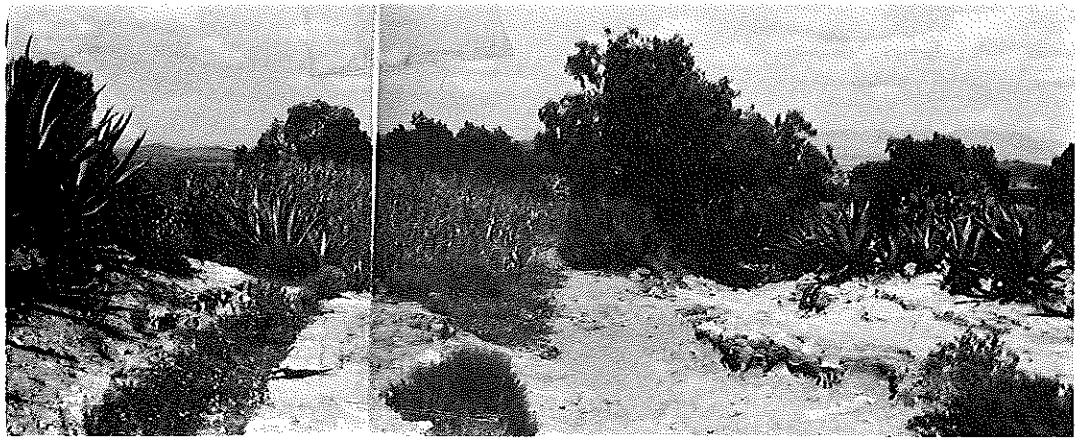

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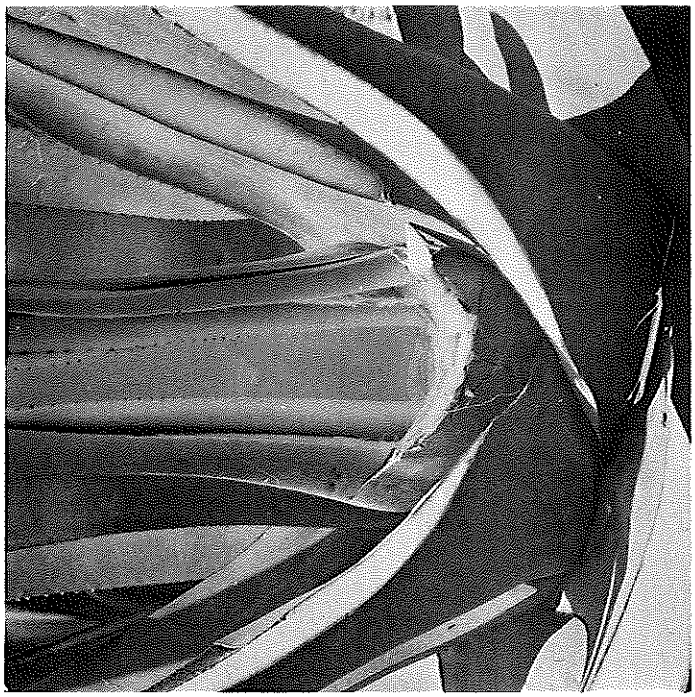

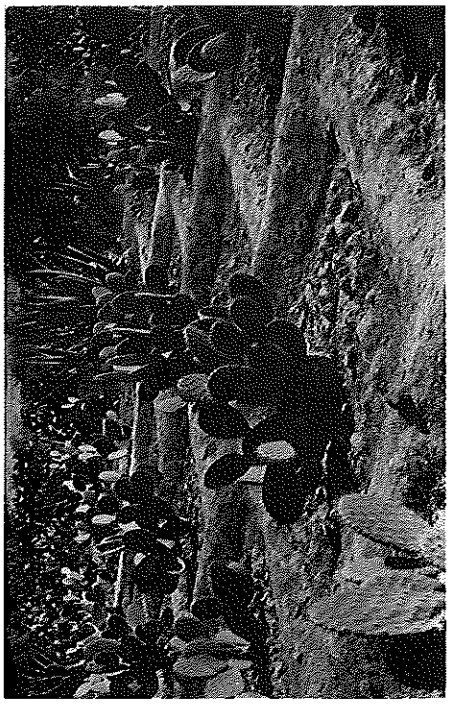

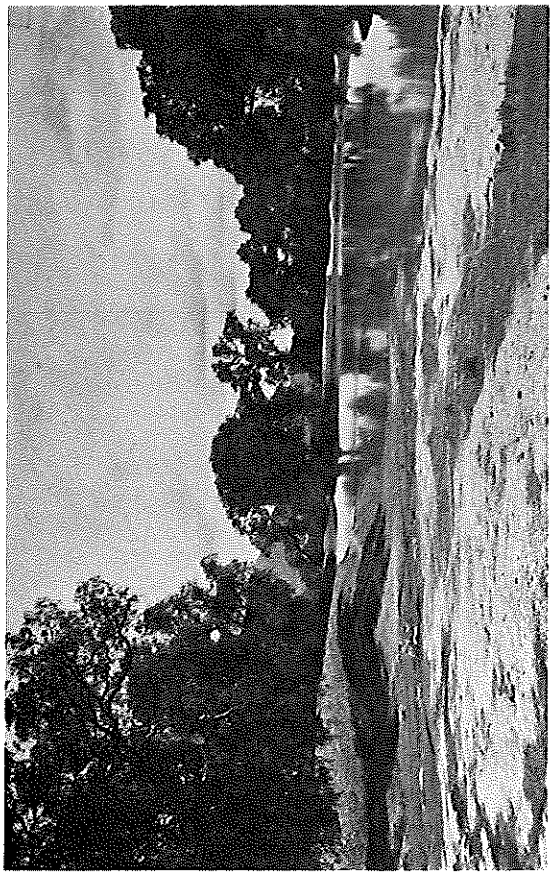

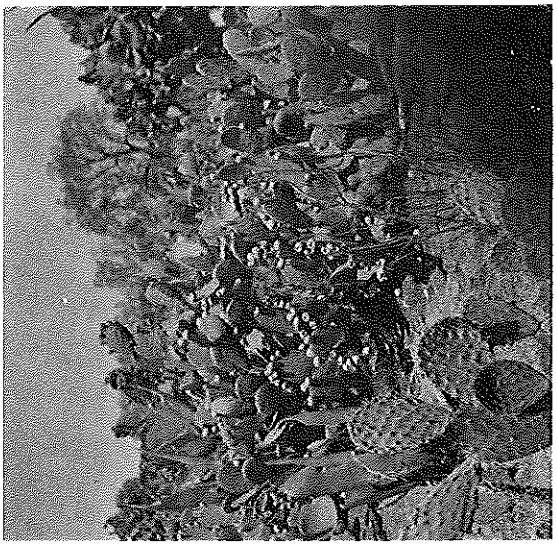

Plate 11

THE POPULATION OF THE TEOTIHUACAN VALLEY, THE BASIN OF MEXICO AND THE CENTRAL MEXICAN SYMBIOTIC REGION IN THE SIXTEENTH CENTURY

by

William T. Sanders

Table of Contents

I. Introduction 388

II. The Population of Central Mexico, 1530-1595, The Cook-Borah and Simpson Studies 389

1. Introduction 389
2. Sources of Data 390
3. The Accuracy of the Censuses 393
4. Conversion Ratios 395
5. The Non-Tributary Population 399

III. The Population of Central Mexico in 1519. The Cook-Borah and Simpson Studies 402

1. Clerical Estimates 402
2. Military Estimates 402
3. Estimates of Town and Provincial Populations 404
4. The Aztec Tribute List 410

IV. The Population of Central Mexican Symbiotic Region in 1519-A Reevaluation 412

1. Methodology 412
2. The 1568 Population 413
3. Earlier Censuses 423

V. The Population of the Teotihuacan Valley - Past and Present 430

1. Contemporary Population 430
2. 16th Century Population 430
3. Agricultural Productivity 438

VI. The Political Demography of the Basin of Mexico in 1519 443

1. Distritos and Domains 443
2. Community Size 445
3. The Special Problem of Tenochtitlan 447
4. The Urban-Rural Ratio 449

Bibliography 455

ILLUSTRATIONS

Fig. 1 - Cholula, 16th Century Population History. 451
Fig. 2 - Tepoztlan, 16th Century Population History. 452
Fig. 3 - 16th Century Population History of Area Included in Document 825 (ENE). 453
Fig. 4 - Central Mexican Symbiotic Region: Possible 16th Century Population Curves 454

I. INTRODUCTION

One of the major objectives of the Teotihuacan project was to establish a relative, possibly an absolute picture, of population distribution and history in the Valley. We are convinced as to a positive correlative relationship between societal evolution and demographic processes and view the project as a test of this theoretical position. During the Classic, Postclassic and Postconquest periods the Central Plateau of Mexico played an extraordinarily dominant role in the culture history of Mesoamerica. It was in this area that the largest cities and states were found and the growth of these cities and states, to a great degree, determined the course of Mesoamerican history over a period of 2000 years. To a great degree this dominance was the product of demographic factors and processes. Within the Plateau was a core area where the population was heavily concentrated and where the great Classic and Postclassic cities were located. It includes the Basin of Mexico and adjacent areas in southern Hidalgo, southwestern Tlaxcala, the western third of Puebla and the State of Morelos. Sanders has refered to this area as the Central Mexican Symbiotic Region (1956).

In this paper we will attempt to reconstruct the political demography of the Teotihuacan Valley, the Basin of Mexico and the Central Mexican Symbiotic Region for the year 1519. The evidence will be based on documentary sources from the 16th Century, checked against Charlton's studies of present day agricultural systems and Diehl's analysis of recent population history and distribution. In a later volume in this series we will test the conclusions against our data from Aztec archaeological sites. Moving one step further we hope to use the Aztec population data as a yardstick to measure the population of the Teotihuacan Valley in the earlier period. Hopefully we will be able to present a picture of population size and distribution for all of the major periods of human population of the Valley. The significance of these demographic patterns with respect to culture process will then be analyzed in detail in the final volume of the series.

II. THE POPULATION OF CENTRAL MEXICO, 1530 - 1595

THE COOK, BORAH AND SIMPSON STUDIES

1. Introduction

In 1948 Cook and Simpson wrote a monograph entitled "The Population of Central Mexico in the 16th Century." In this study they utilized Spanish secular and ecclesiastic tax lists and censuses to establish a population datum for the year 1565 for the region of Mesoamerica they call "Central Mexico." This includes the area embraced by approximately the states of Vera Cruz, Oaxaca, Guerrero, Puebla, Tlaxcala, Morelos, Mexico, Hidalgo, the Distrito Federal, Michoacan, Jalisco, Colima, and Nayarit plus small portions of Zacatecas, Queretaro, and San Luis Potosi. They also attempted to arrive at an estimate for the population in 1519 based on statements as to the population of communities and provinces and the size of Indian armies by the Spanish soldiers; and by the early missionaries as to the number of conversions made during the first decade after the Conquest. On the basis of this data they arrived at a population figure of 4,409,180 for 1565 and 11,000,000 for 1519. Utilizing these two datum points and data from other censuses for a small sample of communities ranging in date between 1553-1571 they calculated a curve of population decline between 1519 and 1565. By using the same procedure, plus overall census calculations by the Spanish authorities themselves, they also calculated a population curve for the period between 1565 and 1607.

The report produced a lively controversy with respect to their estimates and methodology and stimulated a great number of subsequent papers and monographs by Cook, Simpson and Borah.

In 1960 Borah and Cook published "The Population of Central Mexico in 1548." This study was primarily an attempt to utilize the Suma de Visitas to establish a reasonable population figure for the mid-point of the 16th Century.

In the same year Cook and Borah published a monograph entitled "The Indian Population of Central Mexico, 1531-1610." In part this was a reevaluation of the Cook-Simpson study of the population in the 1560's with corrections of errors in the earlier study. (primarily in the elimination of overlaps of census data and changes in conversion ratios). They also examined the rather scanty and highly variable tax data from the Second Audiencia (1530-1536) to establish a population estimate for the 1530's and re-examined the data from the period between 1570-1610 to establish population estimates for two datum points, 1595 and 1605. As a product of these two monographs the authors revised the population estimates from the earlier Cook and Simpson figures.

In 1963 Borah and Cook, in a third monograph, attempted to use the Mendoza Codex and the Matricula de Tributos (two surviving copies of the tax list of the Aztec empire) to achieve a population estimate at the eve of the Spanish Conquest. On the basis of these documents they estimated a population of 25,200,000 for Central Mexico with a possible range of between 18,000,000-26,300,000, a figure approximately double the estimate of the Cook and Simpson study.

The population of Central Mexico between 1519-1607 as derived from these studies can be summarized as follows:

Date	Cook-Simpson (1948)	Date	Cook-Borah (1960, 1960, 63)
1519	11,000,000	1519	25,200,000
1532			16,600,000
1540	6,427,466	1548	6,300,000
1565	4,409,180	1568	2,650,000
1580			1,900,000
1597	2,500,000	1595	1,375,000
1607	2,014,000	1605	1,075,000

In summary the Cook-Borah studies resulted in a sizeable reduction of the figures for the period between 1565-1607, but on the other hand, a considerable increase in the estimates for the period between 1519-1548, as compared to the Cook-Simpson figures. The implication here is one of a much steeper decline as compared to the earlier study.

We will now examine the sources for their estimates and discuss their population figures and the methodology for deriving them.

2. Sources of Data

Within a decade after the fall of Tenochtitlan the Spanish institutions of church and state were introduced into Central Mexico. Prior to the establishment of the First Audiencia in 1528 no formal tax structure was established. During part of that time Cortez was governor of the newly conquered territory and was primarily occupied in military expeditions to pacify outlying provinces, and in the reconstruction of Mexico City as the colonial capital. He exacted informal taxes in labor, goods and services from a number of towns in Central Mexico during the period of his governorship. The church was primarily concerned with a program of missionization by mass baptisms and accurate data utilizable in population estimates were not compiled.

During the First Audiencia (1528-1530) a formal tax system was established. The old Indian states were converted into tax districts; each consisted of a center or cabecera and dependent settlements variously called aldeas, sujetos, barrios or estancias. The majority of these tax districts were made tributary to the Crown, the balance, 180,000 Indian tributaries in all, according to one overall estimate, (see Gibson 1964) were assigned to 30 encomiendas. No standard tax ratios were established and the amount of the tax exacted per capita by crown and encomendero varied considerably from tax district to tax district. Excesses within the system were notorious and the basis of continuous complaints of the Indians. The constant abuse and injustices resulted in an acrimonious debate between Nuno de Guzman, president of the Audiencia and the Bishop Zumarraga. The tax system was

apparently modeled on the aboriginal pattern which seems to have had the following characteristics:

A large tax exempt class existed that included nobles by birth, nobles by military achievement, and various types of serfs or mayeques, some attached to the state, others to the temples, others to private estates. There were also variations in the kinds of taxes paid by the tributary population. Craftsmen and merchants were exempt from corvee labor and taxes in agricultural produce. The bulk of the population consisted of peasant farmers who paid taxes in agricultural produce, labor for public construction and household services in the houses of the nobles.

The structure was slightly remodeled for Spanish use. The encomendero received goods (cacao, cotton, salt, cloth, lumber), agricultural produce, corvee labor for house construction and agriculture, and daily household services and goods in the form of firewood, processed and cooked food, poultry and servants. Comparable services and goods were exacted by the Crown. The hereditary Indian nobility were tax exempt and were allowed to maintain their estates and attached serfs, the latter being also tax exempt with respect to Crown and encomienda. Some of the tax exempt population formerly assigned to temples and palaces were re-assigned to the church and municipal governments and continued their tax exempt status. Also tax exempt were the old and infirm.

The First Audiencia was extremely unpopular and was finally replaced by the Second Audiencia that functioned between 1530-1535. During this period a serious but apparently unsuccessful attempt was made to correct the abuses of the tax system. Between 1528-1535 two minor epidemics (see Gibson 1964) occurred that resulted in some population loss consequently aggravating the Indians' problems of tax payments. Taxes were revised in some cases, particularly in the Crown holdings and a central register of taxes established called the "Matricula de Tributos." Generally speaking however the reforms were not too effectual (see Zorita 1941 edition).

In 1536 the office of Viceroy was created, in part to provide a more effectual executive and judicial structure for New Spain. The first Viceroy, Antonio de Mendoza, held office until 1550. During his administration a minor epidemic occurred in 1538, followed in the period 1545-48 by a series of epidemics of major proportion that ravaged the colony and resulted in an extremely heavy loss of life. This was followed by another minor epidemic in 1550. This enormous loss of life produced serious economic hardships and the period is rife with Indian complaints about their inability to meet the tax schedules established by the Second Audiencia. After the 1545-48 epidemic the situation became so serious and tax payments were so far out of balance in relationship to population that a census was conducted of the population and an investigation of the tax rates made. The investigation was conducted by special emissaries sent by the Crown, in part based on "on the spot" censuses made by them, in part by information derived from local informants. The census took approximately four years to complete (1547-51) and the final report was a document called the "Suma de Visitas." The tribute schedule contained in the Suma is mostly that established by the Second Audiencia; the population census dates from the time of the investigation. Borah and Cook

converted the various goods and services into the contemporary monetary scale and by a comparison of taxes and population demonstrated that there was wide variation in the amount of tax paid per capita - from 2.01 to 63.2 reales! This simple fact dramatically illustrates the ineffectuality of the Second Audiencia and Mendoza's administration, in correcting abuses and their complete inability to keep tax schedules in any reasonable relationship to population.

The Suma contains information on 1200 cabeceras and their tax districts (probably about half of those in existence in Central Mexico at that time). Unfortunately, the census itself was only a partial one, in the majority of the towns, only tributarios or tribute payers were counted and tax exempt groups were excluded from the census.

In 1551 Mendoza was replaced as Viceroy by the first Luis de Velasco. The Suma was completed during the two years that witnessed the change of command. A number of complaints as to the accuracy of the census led to a series of re-checks in the 50's, and during the same period tax schedules were revised on the basis of the various censuses. Such reforms were carried out primarily on the crown holdings and then only incompletely.

In 1556 Philip II ascended the throne of a bankrupt kingdom. In order to raise funds for the royal treasury a new tax law was promulgated in which all exemptions, except the caciques or native dynastic chiefs and immediate families, the aged and infirm, were abolished and for the first time a standard head tax was established. After several revisions an annual tax of 1 peso of gold and half a fanega of maize per year was set for each married man. Widows, widowers and unmarried adults were classified as half tributaries and taxed at a rate of 1/2 of married men. Between 1557-1565 the new tax reforms were extended over the entire area of Central Mexico. The tax lists from this period and particularly from after 1565 can therefore be easily converted to total population.

The period between 1556-1576 was also one of relative economic prosperity but minor epidemics (1550, 1558, 1559, 1563-64 and 1566, (see Gibson op cit) continued to plague the Indian population. As a result of the problems engendered by this further population loss and other fiscal problems Philip ordered a new assessment of the population and natural resources based on data compiled by investigators and local officials between 1575-1580. Unfortunately the censuses coincided with the second major epidemic of the 16th Century and a series of diseases ravaged the country between 1576-1581 with the result of extremely heavy loss of life. Gibson also reports subsequent epidemics of minor proportions in 1587-88, 1590, 1592-97 and 1601-02.

During the period subsequent to 1556 the tax structure remained stable, frequent censuses were taken and taxes were periodically readjusted. None of these records, however, have survived in complete form.

At approximately the same time as the establishment of the cabecera sujeto administrative district the church instituted its own administrative system that included three levels in descending order of size, arzobispado, obispado and parroquia. The parroquia was equivalent to what in English one would call

a parish. It included a main church with a resident priest and a series of smaller dependent churches called visitas that were visited on a regular itinerary by the parroquia priest. In many cases, but not all, the parroquia coincided with the cabecera-sujeto district, the parroquia church being located in the cabecera and the visita churches in the dependent settlements. Periodic censuses were conducted by ecclesiastic authorities, at least after 1560 and this body of independent data can be directly compared to the tax censuses. The ecclesiastic censuses are as variable in content and terminology as are the tax documents however, and some censuses include only adult married males, others the number of confessees (males over 14, females over 12) still others the entire population over four years of age.

Cook and Borah examined a great number of the 16th Century civil tax lists and ecclesiastic censuses and assigned a letter key to identify them. The Suma, for example is identified as Source A. In this study we have used this key and the reader is referred to their earlier work.

There are a number of problems involved in the utilization of these sources to derive reasonably accurate estimates of the 16th Century population. These may be summarized as follows:

3. The Accuracy of the Censuses

One problem that Cook, Simpson and Borah have greatly underestimated is that of the accuracy of the censuses. Even in cases where no intentional fraud was involved we suspect considerable inaccuracies. In many parts of Central Mexico the settlement pattern was extremely dispersed and census taking must have encountered considerable difficulty. As they point out, not all of the censuses were conducted by the Crown inspectors, but were frequently based on local officials and informants. Furthermore, even in areas where the population was nucleated into a relatively small number of large settlements it is doubtful that actual "on the spot" counts were made in all of the sujetos or visitas. Even in contemporary Mexico, in areas of dispersed or nucleated settlements, censuses are not entirely reliable and under the conditions of the 16th Century transportation and communication the problem was even more acute.

Cook, Simpson and Borah to the contrary, (and their own treatment of the subject reveals this) there were both incentives and opportunities for fraudulent censuses. The history of the 16th Century was one of rapid population decline, continuous struggle by the Indians to reduce their tax loads, counteracted by attempts by the Crown and encomenderos to keep the status quo. Cook and Simpson, based on the famous dispute between Cortez and the Crown over the size of his encomienda, argue that most figures when inaccurate were repressed rather than exaggerated. The Cortez estate however was an exceptional, perhaps an unique case. He had originally requested as his encomienda almost the entire Basin of Mexico, the most densely populated area in the newly conquered territory. This request was rejected by the King who was afraid of the possible political power Cortez might exercise with such an estate and he was finally awarded an encomienda that included the modern state of Morelos, the Valley of Toluca, southern Vera Cruz, the Valley of Oaxaca, and the Tacubaya-Coyoacan zone near Mexico City. The official census of this huge territory was only 23,000 vasallos. Secret investigations revealed that the actual figure was several times as high and apparently Cortez intentionally suppressed the real figures to distract the attention of the Crown from his huge holdings.

Most encomiendas however were quite small and the encomenderos in fact exaggerated the census data to support their litigation against a reduction of the tax schedule. This procedure, combined with Indian attempts to show population loss, resulted in a stream of legal suits and investigations by Audiencia and Crown officials. Obviously we are here faced with a very complex situation in which census frauds were expectable in both directions with Indians attempting to show population loss, encomenderos attempting to stabilize tax rates based on earlier censuses and investigators in an extremely exposed position between the factions.

Zurita discusses in detail the problems of census taking and the following quote illustrates the methods.

> Algunos encomenderos suelen, cuando se va a contar su pueblo, nombrar algunos principalejos de sus pueblos o de otros, para que por su parte anden con los que hacen la cuenta, y esto por les agradar, por dadivas o por otros respetos procuran por todas las vias posibles hacer muestra de gente; y lo mesmo hacen algunos encomenderos por su parte, y se ha visto y yo lo he averiguado en visitas que hice, que traen gente de otros pueblos comarcanos, y dicen que se han venido o que se vienen a vivir alli, y cuentanlos por tributarios, y acabados de contar o cuando se les antoja o al tiempo del tributo se vuelven a su natural o se van a otra parte, y asi carga el tributo de ellos sobre los que quedan en el pueblo. (Zurita op.cit. p. 171)

With respect to the Crown dependencies perhaps the problem was less acute. But even in those cases we really have scanty information on the techniques of census taking. In some investigations the Indians themselves provided the census taker with the data. We grant readily, as Cook and Borah argue, that the Indians prior to and after the Conquest, did keep accurate population statistics; but how do we know that they did not provide the Spanish investigator with a doctored or falsified census? The motivation was there and unless the investigator conducted a house by house count deception would be relatively easy. Furthermore some investigators were in fact accused of over zealous devotion to Crown interests, and offered exaggerated census figures. We refer here specifically to the series of censuses conducted by Vasco de Puga in the region around Mexico City in the 1560's. He in turn accused the church of depressing its censuses to protect the Indians from taxation by the state.

Wholly aside from the problems of the accuracy of the censuses there is the problem of completeness of surviving records, overlooking of remote districts or communities, and particularly the problem of overlapping administrative districts. In one particular case, and there are others, the problem is particularly acute.

Prior to the Conquest, Texcoco was the center of an enormous tributary domain that rivaled that of Tenochtitlan. The political structure of this domain was similar to that of the Aztec. It was divided up into a great number of semi-autonomous cabecera-sujeto states each with its own government, headed by its own hereditary ruler who ruled his state with little interference from Texcoco. All paid an annual tribute to Texcoco and other than that little

political integration was achieved. An exception to this rule of semi-autonomy was a large continuous compact territory that included 14 small states plus the core state of Texcoco itself. All but three of these 15 states were located within the Basin of Mexico, east of Lake Texcoco (the exceptions were Tulancingo, Huachinango, and Xicotepec). The population of this area shared a tradition of common origin, dialect and name and the territory was referred to as Acolhuacan. The rulers of the 14 subject states were all related to the Texcocan royal family and acted as an advisory council.

After the Conquest the Texcocan royal family attempted unsuccessfully to claim cabecera status over the entire former tributary empire, and failing in this endeavor, over Acolhuacan. Finally they settled for an extended domain that included the core state of Texcoco plus Huexotla, Chiautla, Coatlichan, and Tezoyuca, all in the immediate area. In some of the Postconquest 16th Century censuses it is not entirely clear whether the data refers to the core state, or the extended domain. Cook and Simpson for example took census data undoubtedly meant to refer to the extended domain and applied it to the core state. With respect to references to the Conquest period, the problem is even more acute as shall be demonstrated at a later point.

4. Conversion Ratios

The data assembled by Cook, Borah and Simpson on Postconquest 16th Century population may be for convenience grouped into two major types. One involves actual population figures or tax assessments levied at a time when the quota per tributary was standardized. The population estimates dating after 1556 are based primarily on this direct evidence. For the period 1531-1556 there are very little direct population data. An exception would be the Suma de Visitas but the rates of tribute per capita at that time were not yet standardized. Their method in such cases was indirect and consisted of a calculation of the monetary value of the various goods and services exacted as tax (based on Cook and Borah's studies of price indices for the 16th Century) and from this data population was calculated based on an assumed average quota.

Direct Data. One of the problems in utilizing the direct data is that of the conversion of the category of persons actually counted to the total population. The earliest document that gives population figures extensively is the Suma. The data from town to town in the Suma is extremely variable. In some documents the count is of casados, vecinos, or tributarios. Cook and Borah demonstrate that at the time of the Suma these terms were synonomous and all referred to an adult married male tax payer. Subsequent to 1556 however the definition of a tributario changed. A whole tributary referred to an adult married male tax payer; viudas (widows), viudos (widowers) and solteros (unmarried adults) were classified as half tributaries. The result was that the term tributario no longer corresponded to a casado or vecino in the later census periods. In order to establish a ratio between the various types of tributaries for calculations of total population in the period after 1556 Borah and Cook (1960) tabulated data from a number of towns where more than one category was given. In a sample of 81 cabecera districts (from documents ranging in date between 1540-1570) the total number of casados was 47761, of viudos 8994. The overall ratio of casados to viudos was therefore 1: .188. The problem of the ratio of casados to solteros was considerably

more difficult since there was apparently great variation in the age and residential status on the one hand and the tributary status for the term soltero on the other. In some censuses only tributario - solteros were counted (prior to 1556). In others the count includes all solteros. Complicating the picture is the fact that soltero tributary status was assigned in different towns at different ages. In some cases only solteros living in separate households were taxed, a pattern that might well have acted to perpetuate the extended family. In others those residing with their parents were taxed as well. Borah and Cook tabulate the data (primarily from the Suma) as follows:

Category	Number of towns	Ratio to casados
Solteros tributarios	12	.103
All solteros above 12 years	12	.274
All solteros above 8 years	3	.832
No age or status given	102	.039-1.435

The data is so variable and indefinite that an overall conversion ratio could be established only with considerable reservations. On the basis of this data however Cook and Borah settle on an overall ratio of .11 tributario solteros per casado. They then state "Thus for every 100 casados there were 23 viudos and 11 solteros, each of whom pay tribute at a lower rate..." In the tabulation of total population for the later censuses they considered that there were 1.17 times as many tributarios as casados or .855 times as many casados as tributarios. In their calculations for earlier censuses they simply equated tributarios with casados.

In order to establish the ratio of casados to total population Cook and Borah surveyed a number of documents, particularly the Suma where categories of population other than casados, viudos, and solteros were given. The Preconquest Aztec states apparently did take complete censuses except that they excluded children below 3 or 4 years of age. This pattern was apparently continued into the 16th Century after the Conquest. In the Suma one-fourth of the cabecera districts provide data for categories of population other than casados. The number and designation of categories from document to document are extremely variable and at times vague. Categories frequently given are casados, viudos, viudas, solteros, muchachas, and ninos. Occasionally the source explicitly states that the count includes all persons (presumably excluding the children below 3 or 4 years). Cook and Borah tabulate the data as follows:

	Number of towns	Ratio-Casados to rest of population
A	12	2.79
B	23	2.95
C	92	3.19
D	91	2.96

The ratio calculated very consistently at approximately 3.0 suggesting

that the looseness of phraseology was an idiosyncracy of scribe rather than of the census procedure and that in all cases the census was meant to include all persons above 3 to 4 years of age. Cook and Borah then used an average ratio of 3.0 to convert casados to population above three to four years of age.

In one set of reports in the Suma, that of the region of Tehuantepec, a complete census was taken including children below 3 to 4 years of age. The latter made up 11.4% of the total population. Borah and Cook cite the 1940 census of Mexico in which the children below 4 years made up 11.4% of the population. On the basis of these calculations they then arrived at a conversion ratio for casados to total population of 3.3.

In the ecclesiastic documents the problem is relatively simple since the census was based on either the casado or a category called "gente de confision." As the sources made clear this category included all males above 14 years of age and females above 12. Cook and Simpson, based on the 1937 census of Mexico, find that this age category comprised 62.6% of the total population. In their later studies Cook and Borah used ecclesiastic documents only sparingly, primarily to check figures from the secular tax lists or to fill out lacunae.

Generally speaking the later censuses made in the 16th Century were of considerably greater reliability than the earlier ones; re-checks were frequent and there is agreement between church and state in many cases. Population data for the first half of the 16th Century however, is highly suspect, and any calculations based upon such data must be used with considerable caution and reservation.

Indirect data. For the period prior to the Suma there is very little direct census data. Borah and Cook established population figures for 1548 based on the Suma and then attempted to establish a population figure for the period of the Second Audiencia based entirely on the quantity of the tax - and it must be emphasized that the earlier taxes were not based on a standardized per capita formula. Their method involved two basic steps: (1) the conversion of the various kinds of goods and services, first to a relative scale then to an absolute scale in terms of the Spanish real; (2) the conversion of this total tax in reales to population. With respect to the first step they assembled data from documents to establish a relative scale of values of goods in the early 16th Century. They were also able to establish a monetary common denominator in terms of Spanish currency. The major problem lies in step 2. Cook and Borah on the one hand have emphasized the fact that there was considerable variability in the quotas paid per tributary family from town to town and the courts were full of complaints of the inequalities of the system. They argue, however that the tribute exacted must have had some relationship to the tributary population and that it must have been within the capacity of the population to pay. We agree, but what does the term "some relationship" mean and what is meant by the "capacity of population to pay." When the Suma investigations were conducted the range of tax per capita from town to town varied from 2.01-63.2 reales per tributary as noted previously; presumably the product of a great number of causes of which variation in population decline and inequalities in the tax structure were the primary factors. With ranges this great, we argue

that population calculations from the tax assessments would be virtually worthless. One could even make the assumption that, without the effective controls established after the 1550's, even the minimal average tax found in the Suma of 2.01 reales was excessive in proportion to living cost standards for the early 16th Century.

In their subsequent discussion Cook and Borah disagree with themselves (they have to if a population figure is to be derived) since they argue for a relatively narrow range of tax variation in an attempt to establish an average payment per married tax payer. They settled on a figure of 1.5 reales per tributary for 1530 and used this as a base for population calculations. This figure is based on the following arguments:

During the 16th Century there was a steady rise in the prices of goods. They were able to establish a price curve based on data between 1551 to 1571. They then projected curve backward and arrived at a figure of 2.0 reales per casado for the 1530's as a reasonable per capita tax in terms of existing living cost standards for that period. They then proceed to test this figure by the following data. A sample of three communities for the period 1526-1536 in which the source provides data on both taxes and population. The range of tax per capita is from .47-2.09 (the very low figure however is from the Kingsborough Codex relating to the town of Tepetlaoxtoc in which all population estimates for the early 16th Century are certainly excessive). They also based their estimate on an extremely vague statement by Zurita referring to the Preconquest tribute and dating around 1565 to the effect that -

> As for the third question, about the value of tributes in terms of gold pesos, this cannot be clearly established, for in those days (before the Conquest) each tributary gave little and what he gave was of little value among them, although worth much today. It is certain that now one tributary pays more than six did then, and one town now gives more in pesos than then did six towns of those that gave tribute in gold, and because the tribute did not cost the labor that it does now it was not valued as highly; but as far as one can guess, everything that a tributary paid, even including service, was not worth more than from three to four reales. (Cook and Borah p. 25)

The statement was clearly not meant to be exact yet Cook and Borah take the ten reales average tax paid in 1565 per tributary, divide by six and arrive at an average of 1.67 reales average tax for 1519. They then argue, on the basis of the 16th Century price curve, that the three to four reales in 1565 would probably be worth one real in 1519, and that their 1.5 figure (see below) for 1530 is therefore reasonable.

Finally their estimate is based on a statement by Bishop Sebastian Ramirez de Fuenleal to the effect that in 1532 the most common annual tax levy were strips of cotton cloth (una pierna de manta) in some regions given every 80 days, four such piernas making up one manta per casado. The price of such a manta in Mexico City at that time, from other sources cited by Cook and Borah, was 2.17 reales. In fact however no towns paid only mantas and their tax included other items, and furthermore the

majority of the towns paid taxes in goods other than cotton cloth. It is possible, but in view of Indian complaints this is doubtful, that taxes in cloth were based on a regular rate since Indian techniques of production were too primitive to permit a very wide range of variability but there is no reason to assume this was true of other commodities. Ramirez de Fuenleal's statement probably relates to an ideal condition, possibly in reference to more equitable Preconquest native tax rates but the history of litigation by the Indians conclusively demonstrates that it was never effectively applied in the Postconquest period.

5. The Non-Tributary Population

The only document prior to the 1556 tax reform that provides abundant direct population data is the Suma de Visitas. A number of writers (Kubler, Cook and Simpson, Cook and Borah) have noted that the population figures in the Suma are consistently and strikingly lower than those reported in later censuses. Kubler suggested that the census was accurate and that there was a population increase in the decades of the 60's and 70's following a sharp decline between 1519 and the date of the Suma. Cook and Borah, however, have argued a continuous decline throughout the 16th Century, a position which is better supported by the documentary sources and with which we concur. The explanation for the lower Suma figures, as Cook and Borah demonstrate, lies in the fact that only tax paying families were included in the Suma count and with the exception of a few documents all tax exempt families and individuals were excluded. A major problem therefore exists, the size of the tax exempt population. The weakest argument in the studies conducted by Cook and Borah on 16th Century demography lies in their statistical manipulations to arrive at a figure for the tax exempt population in 1548.

To establish a ratio of tax exempted to taxed population they first examined 11 documents (of the 1200) in the Suma that provided population figures for both categories. On the basis of these 11 cases (of which 9 were located in Nueva Galicia), they calculated an average of non-tributary to tributary population of 35 per cent. Then they make the assumption, with no justification from statements in the Suma, that this non-tributary population did not include nobles or mayeques but only people living in the "free calpullec" who were exempt. They also make the assumption that 10% of the population were nobles (we think this figure is much too high also) bringing the total non-mayeque elements in the non-tributary population to 45%.

They then deal with the size of the mayeque population separately. On the basis of a sample of only six communities (none from the Suma) where a total count was made that included mayeques, they estimate an average of 35% mayeques. One of the major problems in applying these averages to the total sample (aside from the extremely small size of the base sample) is the fact that Indian society was far from uniform and the mayeque class was found apparently only in some areas. We suspect that the pattern was even more complicated than Cook and Borah imagined and that mayeques were not necessarily present in all communities within a region; the mayeque

status was apparently the product of conquest which means that they were common only in politically powerful communities. Cook and Borah assume that mayeques were present in all communities in the Central Plateau and portions of Oaxaca and were absent in all the other areas. On the basis of this assumption and the averages calculated above, they derived the following formulae for converting the Suma census to total population.

For the Central Plateau and Oaxaca

Tributary Population	43%
Exempt nobles & calpulli population	22%
Exempt mayeque population	35%
	100%

For the rest of the area of Central Mexico

Tributary Population	65%
Non-tributary Population	35%
	100%

We find these arguments extremely tenuous and reject the assumptions upon which they are made. The samples are much too small to establish averages for the huge area embraced by the Suma, and the assumption of uniformity of social structure over such a huge region is unsupported. The assumption that the Suma statements about non-tributaries refer only to free calpulli members is also unwarranted. Only one document (Izucar) contains data on the non-tributary population in the entire Central Plateau area so that we have a sample of only one document that included the tax exempt elements! The Izucar document simply reads that in the town there were "five barrios with 484 casados who did not pay tribute." The term barrio here cannot be assumed to mean only free calpulli members. The term barrio refers to a physical and administrative unit that included sections or wards of communities or isolated settlements and was frequently applied to mayeque settlements as well as free calpulli communities. In his studies of Aztec social structure Carrasco has demonstrated that the nobles of a community were usually members of a single barrio or calpulli and his detailed study of Tepoztlan supports this (as well as the fact that the mayeques were structured into barrios). Consequently the non-tributary population in the Izucar document could have included all non-tributaries, free calpulli members, mayeques, and nobles. (The non-tributaries there made up 34.8% of the census.)

In the case of their tabulation of mayeques from the six communities, the range was between 11.4-57.0%, an extraordinary range for so small a sample that certainly casts suspicion on the averages they used as a reasonable basis for calculations of mayeque population over the entire plateau. The range points out another interesting facet to the entire question of the size of the mayeque population. The rapid reduction of the population during

the 16th Century generated problems for the Indian noble serf holders as well as the Spanish encomendero and the king. They responded by a regularized procedure of illegal conversion of free calpulli members to mayeque status. The result was an increase in the ratio of mayeques to total population and a rash of suits against the nobles by encomenderos and Crown investigators. The peasant himself apparently entered into such contracts willingly, expecting, and in most cases receiving, a lighter tax burden than was exacted by his Spanish masters. In all probability the percentage of mayeques steadily increased during the period from 1519 to 1556 (at the latter date the mayeque system was abolished). Furthermore, we would expect great variability from town to town related to variations in population decline, the economic significance of the mayeque class and political sophistication of the noble class from community to community. One cannot therefore assume that the process was regular (see Gibson's revealing account of the ability of the Tlaxcalans to manipulate the Spanish bureaucratic structure as contrasted to other Indian groups).

Our only good data on mayeque population, in the sense that it is at least based on a large sample, is the statement (cited by Cook and Borah)that there were more than 100,000 mayeques in the area of the Audiencia of Mexico. Cook and Borah calculate a proportion to the total population of only 10% (this is approximately the percentage reported for the 1550's in "Los Bienes de Cortez" for the town of Yecapichtla in a census that was so detailed that it included even the names of each mayeque and of the noble whom he served!). Cook and Borah accept the figure for 1563 but argue that the mayeque population probably declined faster than the free calpulli populations because of their depressed economic status. We see no justification for this argument at all and would even run the argument in the opposite direction, i.e., that the Indian noble was probably a less stern tax master than either the Crown or encomendero and certainly was no more exacting. Furthermore we have presented an argument that the mayeque class was increasing, for the reasons cited. At any rate the figure is obviously a gross estimate and should be used with extreme caution. If it is close to the truth, then the total exempt classes of 1548 need not have comprised more than 20 or 30% of the tributary population in the area where the mayeque system was in vogue, a figure far below Cook and Borah's 57% for the Central Plateau and Oaxaca and 35% of the remaining areas.

III. THE POPULATION OF CENTRAL MEXICO IN 1519 - THE COOK, BORAH AND SIMPSON STUDIES

In 1948 Cook and Simpson attempted to estimate the population in 1519 from two sources. (1) the estimates of Conquistadores as to the number of enemy warriors they fought, and populations of towns and provinces they conquered; and (2) from clerical estimates of conversions made during the decades of intensive proselytization following the Conquest. We feel that estimates based on such data are of very dubious value. Our criticism lies on two assumptions made by the authors, that the estimates are based on relatively reliable data, and that the Spaniards lacked motivation to alter whatever data was available. We disagree with both of these assumptions and Cook and Simpson to the contrary the extraordinary divergence of opinion on Indian population sizes found among the sources cited by them supports our position.

1. The Clerical Estimates

During the 1520's approximately 45 Franciscan monks conducted a series of trips through the country on a great soul saving mission. The Indians would gather in enormous crowds at various places along the route and the monks conducted a mass baptismal service. It is worth quoting Cook and Simpson in full on the statements by the priests as to the number of people baptized.

> In 1531 the Bishop of Mexico, Fray Juan de Zumarrage,[3] stated that by that time "more than a million persons" had been baptized. Later, Motolinia[4] said that between 1521 and 1536 "more than four million souls were baptized." This figure is raised to 5,000,000 by Mendieta, who adds that by 1540 it had risen to not less than 6,000,000.[5] The analysis of baptismal figures by Motolinia is the most detailed that we possess and is worth citing in extenso to demonstrate the sincerity, if not the statistical competence, of this famous missionary. He uses two methods, which are summarized below.
>
> a) By priests. In 1536 there were sixty Franciscan priests in all New Spain. (The other orders had not yet baptized many Indians, according to Motolinia.) In addition, forty others had been there, but of these twenty had returned to Spain and twenty had died. Five of those no longer present had baptized about 100,000 each, or 500,000 in all. Forty of those still present had likewise baptized about 100,000 each, or 4,000,000 in all. The total would be about 4,500,000. Torquemada, writing at a later date, supports Motolinia by citing names: according to him, Fathers Cisneros, Caro, Perpinan, and Facuencia performed more than 100,000 baptisms each, and Father Motolinia, 300,000.
>
> b) By regions. Motolonia specifies the following towns and provinces:

1.	Mexico, Xochimilco, Tlamanalco, Chalco, Cuernavaca, Yecapixtla, Huaquechula, Chietla	+1,000,000
2.	Texcoco, Otumba, Tepeapulco, Tulancingo, Cuautitlan, Tula, Xilotepec	+1,000,000
3.	Tlaxcala, Puebla, Cholula, Huejotzingo, Calpa, Tepeaca, Zacatlan, Hueytlalpa.	+1,000,000
4.	South Sea Coast	+1,000,000
5.	Converted since this calculation was made	500,000
	Total	4,500,000

Motolinia thought this estimate too conservative and hazarded the opinion that the number reached 9,000,000. However, if we allow an additional 500,000 to account for regions not covered in his list, we get 5,000,000. A further million baptisms between 1536 and 1540 and would yield Motolinia's figure for that date.[7] (Cook and Simpson pp. 19-21)

The account indicates that no accurate counts were made and that the monks disagreed among themselves as to the number. Motolinia himself apparently placed little faith in such figures since he states that over 4,000,000 were baptized but that the real number could have been as high as 9,000,000! Yet Cook and Simpson do accept the numbers and use them as a basis for their population estimates! The lack of preciseness in such estimates is understandable. No records were kept and one suspect's a pardonable amount of excess zeal. In short the clerical estimates of baptisms are worthless as the basis for population calculations.

2. Military Estimates

The same objections to the use of clerical estimates apply with even greater vigor to estimates based on the size of Indian armies stated by the Conquistadores to have fought with or against them in the various campaigns between 1519 and 1521. First there is the simple problem of establishing the size of the territory from which the warriors were gathered. Cook and Simpson argue for example that the enemy forces at Otumba were composed of warriors drawn from Tenochtitlan and the mainland settlements west of Lake Texcoco and use the figures as a basis for calculations of population from that portion of the Basin of Mexico. Bernal Diaz however states that they came from all the towns around the lake including Texcoco.

Secondly, there is little basis for the extraordinary faith the authors have in estimates made by Cortez. His legal position was exceedingly precarious throughout the Conquest (particularly prior to the Narvaez expedition - Narvaez was specifically commissioned to imprison him for disobedience) and the tone of his letters was clearly calculated to impress the Spanish king. After the Conquest he was in constant "hot water" over his political ambitions and his biography, written by Lopez de Gomara, was obviously a propaganda device to improve his position at Court. Furthermore, there is the very serious question as to the possibility of making even rough approximations as to the size of Indian armies.

Finally as Table 1 demonstrates there is not fundamental agreement (Cook and Simpson to the contrary) on the part of the various documentary sources as to the number of men in the native armies.

Table 1.

Sizes of Indian Armies According to Various Spanish Sources

	Battle	Cortez	Diaz	Tapia	Gomara	Herrera	Ixtlilxochitl	Oviedo
1.	Tlaxcalans			over				
	Battle 1	100,000	40,000	100,000	80,000	150,000		
	Battle 2	149,000	50,000		150,000			
	March to Cholula	100,000	1,000	40,000	100,000			
	Assembly following Otumba battle					200,000		
	Tepeaca Campaign		4,000		40,000	56,000		
	Siege of Tenochtitlan	25,000	16,000		60,000	30,000	25,000	
		45,000	20,000			60,000		
						110,000		
2.	Aztecs and Allies							
	Second March to Tenochtitlan	150,000						
	Battle of Otumba				200,000	200,000		
	Siege of Tenochtitlan						300,000	
3.	Texcocans							
	Military resource of province						200,000	
	Siege of Tenochtitlan				50,000	50,000	58,000	
4.	Total Indian Allies of Cortez							
	Siege of Tenochtitlan							
	Initial	75,000	24,000		100,000			
	Final	150,000	over 100,000		200,000	200,000	300,000	130,000
5.	Indian Allies of Cortez							
	Southern Campaign	100,000			100,000			
		120,000						

3. Estimates of Town and Provincial Populations

Somewhat more useful are the statements by the Spanish sources as to the population of towns and districts. The same problem of intentional manipulation of the data, however, may be assumed for these figures. With respect to the bases of the figures Cook, Simpson and Borah argue that the Indian states took population censuses for the purposes of taxation and that careful records were kept. We agree, but the question is: Did Cortez have access to such records?

How was the information relayed to him? Did the Indians give him reliable data? Or did they exaggerate the figures to discourage him? (The Cacique of Tzaoctlan's statement that Moctezuma had 30 vassals - each with 100,000 warriors is the case at point). Or did Cortez simply estimate on the basis of his impression of the size of the community? And finally, regardless of the sources of information how much did he doctor the figures to magnify his exploits and achievements? It seems to us that Cook and Simpson grossly underestimate the problems of utilization of such data.

Finally, there is the even more serious problem as to what the figures refer to. In Aztec times, the population was organized into a great number of small states, each consisting of a central town and dependent villages and hamlets. This was the largest stable political unit within which the social contract of obligations and privileges between the various social classes was accepted and legal. The Spaniards in referring to the rulers of such states called them "Los senores naturales" - the natural lords. Historically one or another of these states would conquer its neighbors and exact an annual tribute. But this tribute was considered by the conquered state as an illegal imposition and was paid only as long as the conquerors were able to enforce it. Generally speaking, the local political system was unmodified by this suzerainty. Aside from these conquest-states, above the level of the local states were, what might be called ethnic provinces, provinces within which were a number of politically autonomous states that shared a common dialect, name and tradition of a single origin based on a migration myth. Within the Basin of Mexico were a number of these groups, the Acolhuas, Chalcas, Xochimilcas, Tepanecas, and the Culhua-Mexica or the Aztec. The few cases where more highly integrated supralocal political systems did emerge in the history of Central Mexico involved these ethnic provinces. We noted the case of Texcoco and the ethnic province of Acolhuacan.

After the Conquest the Spaniards converted most of the local states into tax districts retaining the old central Aztec town as the cabecera. The tax and census data of the Post contact period refers to the population of the tax districts, except in cases where a community by community census is provided.

In many cases of Conquest period population figures it is not clear which of these levels are intended. In their 1948 publication Cook and Simpson assume that estimates of populations of "pueblos" by Cortez and other Conquest period accounts refer to the local state and on page 37 these estimates are compared with their calculations of the population in 1565 of the equivalent Postconquest tax districts. They then argue that the rate of decline revealed by a comparison of the two figures is a reasonable one. It is quite clear in most cases from the context and wording however, that Cortez and others refer only to the cabeceras or towns, not the entire district. In the case of Huaquechula Cortez explicitly states that there were 5-6,000 vecinos in the town and as many more in the surrounding province. The wording of many of the other statements by Cortez or his biographer, Lopez de Gomara, is such that the figures obviously refer to towns, not districts, as the following quotes illustrate.

Terna esta ciudad de Iztapalapa doce o quince mil vecinos; la cual esta en la costa de una laguna salada grande, la mitad dentro en el agua y la otra mitad en la tierra firme. (Cortez p.174)

Y dejandolos asi muy contentos, me parti, despues de haber estado alli cuatro o cinco dias, y me pase al asiento del otro senor, que esta las dos leguas que dije el valle arriba, que se dice Izatacmastitan.[1] El senorio deste seran tres o cuatro leguas de poblacion, sin salir casa de casa, por lo llano del valle, ribera de un rio pequeno que va par el; y en un cerro muy alto esta la casa del senor, con la mejor fortaleza que hay en la mitad de Espana, y mejor cercada de muro y barbacana y cavas; y en lo alto deste cerro terna una poblacion de hasta cinco o seis mil vecinos, de muy buenas casas, y gente algo mas rica que de la del valle abajo. E aqui asimesmo fui muy bien recibido, y tambien me dijo este senor que era vasallo de Muteczuma. (Cortez p. 146)

En los capitulos pasados, muy poderoso Senor, dije como al tiempo que yo iba a la gran ciudad de Temixtitan me habia salido al camino un gran senor, que venia de parte de Muteczuma; e segun lo que despues del supe, el era muy cercano deudo de Muteczuma, y tenia su senorio junto al del dicho Muteczuma, cuyo nombre era Haculuacan. E la cabeza del es una muy gran ciudad que esta junto a esta laguna salada, que hay desde ella, yendo en canoas por la dicha laguna hasta la dicha ciudad de Temixtitan, seis leguas, y por la tierra diez. E llamase esta ciudad Tezcuco, y sera de hasta treinta mil vecinos. Tienen, senor, en ella muy maravillosas casas y mezquitas, y oratorios muy grandes y muy bien labrados. Hay muy grandes mercados; y demas destas hasta ciudad, tiene otras dos, la una a tres leguas desta de Tezcuco, que se llama Acuruman[2], y la otra senorio de Haculuacan otras aldeas y alquerias en much cantidad, y muy buenas tierras y sus labranzas. E confina este senorio por la una parte con la provincia de Tascaltecal, de que ya a vuestra majestad he dicho. (Cortez p. 191)

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[1] Ixtacamaxtitlan

[2] Acolman.

The wording from the references would also suggest that Cortez was supplying his own estimates, not figures based on Indian informants since the latter would probably provide data for the entire political district, not just the central town. This is also indicated by the fact that Cortez at times gives the population in vecinos, at times casas, and apparently used the term synonymously as they were in contemporary Spain. He probably did not realize the Aztec tendency for multi-family residence. This last fact presents even more serious problems in calculations of population from the Conquest sources. All writers, including Cook and Simpson, have used as conversion ratios, for populations given in counts of houses, 4 to 5 persons per casa or per vecino. The documentary evidence however

is conclusive as to the custom of multi-family residence. Cook and Borah found a number of documents in the Suma that give data on the ratio of "casados" to "casas" in 1548. The data tabulates as follows:

Area	Number of Tax Districts	Ratio of Casado to Casa	Number of Tax Districts	Ratio Personas to Casa
Mexico-Hidalgo	60	2.93	17	6.34
Oaxaca (except Zapotecas)	50	1.67	12	4.67
Morelos-Guerrero	8	1.67		
Puebla	56	1.26		
Vera Cruz	14	1.48		
Oaxaca-Zapotecas	45	1.30		
Jalisco-Nayarit			35	6.21
Michoacan			53	5.23
Sinaloa	33	1.75		

Within the Central Plateau area, that under discussion, the average household membership was 2.93 married men and 6.34 people, excluding children below four years of age. Calculating for them the average house contained approximately 7 persons, not 4 - 5. Carrasco's intensive study of Tepoztlan of a document dating from the Second Audiencia revealed an average of 1.5 casados per casa and a household population of 5.6 persons (also probably excluding children below 4). A document in reference to Cortez's estate in the Toluca Valley based on a secret investigation states that the 20,000 casas in the area contained 50,000 casados (E.N.E. Volume 2, page 124) or an average of 2.5. If we apply these ratios to the figures given by the Conquistadores we arrive at impossibly high populations. For example the cabecera of Acolman in the Teotihuacan Valley would have had a population of 21-28,000 inhabitants (3-4,000 casas). The archaeological remains indicate a town of no more than 4 or 5,000 inhabitants. (These calcualtions assume that the size of the extended family remained constant between 1519 and 1548 which is by no means certain).

Finally the various documentary sources are not in substantial agreement as the authors claim (except where one copies from the other). Tlaxcala (in this case the province) is variously estimated at having a population of 50,000, 150,000, 200,000 and 500,000 vecinos. The population of Texcoco is variously estimated at 8,000, 20,000, 30,000, 70,000 and 140,000 casas or vecinos. For Ixtapalapa there are estimates of 8,000, 10,000, 12,000 and 15,000 casas. For Tenochtitlan from 60,000 inhabitants to 60,000 casas or vecinos to 120,000 casas or vecinos. Tables 2 and 3 summarize the data:

TABLE 2

Comparison of Population of Indian Towns According to Various Spanish Sources

Town	Martyr (casas)	Mendieta (vecinos)	Hernandez (casas)	Tapia (Habitantes)	Cortez	Gomara	Ixtlilxochitl	Salazar (casas)
Ixtacamaxtitlan	5-6,000				5-6,000 vecinos	5,000 vecinos		
Tlaxcala (Province)		200,000			500,000 vecinos (incl. Huejotzingo)	150,000 vecinos 50,000 vecinos		
Texcoco (Town)	30,000	30,000			30,000 vecinos	"As many as Tenochtitlan" 30,000 casas	70,000 vecinos	
Texcoco (Province)	Many towns 3-4,000				150,000 hombres			
Namless town in Tlaxcala	3,000				3,000 casas	3,000 casas		
Huejotzingo		80,000						
Teotihuacan		2,000 (1520's)						
Cholula-Center	20,000					20,000 casas		20,000
Suburbs	20,000					20,000 casas		20,000
Amecameca (Province)	20,000				20,000 vecinos	20,000 vecinos		
Mixquic	1,500				1-2,000 vecinos			
Tlahuac	2,000	vecinos			2,000 vecinos	2,000 fuegos		
Ixtapalapa	8,000				12,000 vecinos	10,000 casas		
Culhuacan	8,000				15,000 vecinos			
Mexicalcingo	3,000				3,000 vecinos	4,000 casas		
Coyoacan	6,000				6,000 vecinos	6,000 casas		
Huitzilopochco	4,000				4-5,000 vecinos	5,000 casas		
Tenochtitlan	60,000		60,000	60,000		60,000 casas		
Hueyotlipan	4,000					4,000 vecinos		
Huaquechula (Pueblo)	6,000				5-6,000 vecinos	5,000 vecinos		
Province					10-12,000 vecinos			
Itzzocan	3,000				3-4,000 vecinos	3,000 casas		
Acolman					3-4,000 vecinos			
Otumba					3-4,000 vecinos	"A trifle less than Texcoco"		
Zautla					5-6,000 vecinos			
Zumpancingo						30,000 vasallos 20,000 casas		
Basin of Mexico			50 towns Many 5,000 casas, others over 10,000			50 towns, many 5,000 casas, others over 10,000		
Aztec Empire						30 vasallos Each one 100,000 guerreros		

TABLE 3.

Torquemada's Classification of Population Centers

	Casas or Vecinos
First Class (over 100,000 casas)	
Tenochtitlan	120,000 casas, in each casa 1,3,4,10 vecinos
Texcoco	140,000 casas, but some barrios 3-4 leagues from center
Second Class (over 20,000 vecinos)	
Cholula	20,000 vecinos in city, 20,000 more in suburbs
Huejotzingo	35-40,000 vecinos
Tepeaca	Over 30,000 vecinos
Xochimilco	Over 30,000 vecinos
Chalco	Over 30,000 vecinos
Tlalmanalco	Over 30,000 vecinos
Amecameca	Over 30,000 vecinos
Third Class (10-15,000 vecinos)	
Otumba	Xilotepec
Tlacopan	Ixtapalapa
Azcaputzalco	Huitzilopochco
Quauhtitlan	Coyoacan
Tepexic	Toluca
Tula	Cuernavaca
Fourth Class - Villas or Aldeas (below 1,000 vecinos)	

What is even more disconcerting in the use of such estimates to achieve a population figure for Central Mexico is the fact that many of them are based on one primary source, Cortez (even Torquemada who seems to have simply used a regular procedure of doubling Cortez' figures!). Peter Martyr's figures were obtained from various emissaries sent by Cortez to the court, Lopez de Gomara wrote his biography of Cortez under his direction, and most of the others restated the figures provided by Cortez and his biographer. The only other independent sources are Bernal Diaz, who provides very few population figures, and Andres de Tapia, who is the source of the sharply divergent and highly controversial statement that Tenochtitlan had 60,000 inhabitants. Finally although Bernal Diaz provides us with very little demographic data he completely rejects the estimates

of the size of Indian armies, towns and provinces provided by Cortez and his biographer, as the following quotes from his book clearly indicate.

> Gomara also greatly exaggerates the numbers of our Indian allies, and the population of the country beyond all reason; for it was not the fifth part of what he represents it. According to his account there would have been more thousands here, than inhabit all Castille; but where he has written eighty thousand we should read one thousand. All this he has done in order to make his narrative the more agreeable. (Bernal Diaz XXV)

> I Bernal Diaz Del Castillo, regidor of this loyal city of Guatimala, and author of the following most true history, during the time I was writing the same, happened to see a work composed by Francisco Lopez de Gomara, the elegance of which made me blush for the vulgarity of my own, and throw down my pen in despair. But when I had read it, I found that the whole was a misrepresentation, and also that in his extraordinary exaggerations of the numbers of the natives, and of those who were killed in the different battles, his account was utterly unworthy of belief. We never much exceeded four hundred men, and if we had found such numbers bound hand and foot, we could not have put them to death. (Bernal Diaz p. 272)

4. The Aztec Tribute List

In 1963 Borah and Cook attempted to establish a new population estimate for Central Mexico on the eve of the Spanish Conquest. The approach was similar to Cook and Borah's calculations of the population in the 1530's. They used the tribute estimates of the Aztec empire as contained in three surviving documents, the Matricula de Tributos, the Mendoza Codex, and the Scholes document, to establish the size of the population in 1519. Their discussion of the use of this material to arrive at population estimates is particularly puzzling since the authors themselves provide us with a detailed and excellent analysis of all the problems and objections to such use. Their own analysis leads the reader to the almost inescapable conclusion that it cannot be done! The major problems seemed to be:

(a) The tribute collected by the Aztec was not based upon a head count and the relationship therefore between taxes and population is an exceedingly tenuous one.

(b) The Aztec rulers intentionally gave the conquered groups differential treatment; some were heavily taxed, others had only military obligations. The basis of this differential treatment seems to have been primarily one of relative degree of resistance to the initial Aztec demand for tribute.

(c) The tribute was levied in kind, varying in particular goods from province to province. In some areas feathers were paid, in others, honey, cacao, or maize, etc. There is no indication in the sources that any master plan of relative values between type of goods (certainly not in terms of provincial population) ever existed. There are post-Hispanic references to the relative values of goods, which the authors use to establish a common denominator. It is very probable however that such relative values varied from market to market, season to season, and year to year, and certainly post-Hispanic values cannot be applied to the pre-Hispanic period. There are statements in the sources dealing with

the Postconquest period to the effect that agricultural production had declined sharply since the Conquest and that the price of foodstuffs had increased relative to Spanish currency and Indian barter patterns. The ratios then are clearly not applicable to the pre-Hispanic period.

(d) In many cases Texcoco and Tenochtitlan exacted tribute from the same district, but the authors use only the Tenochca tribute list.

(e) The authors argue that a certain proportion of the population of the local conquered state was tax exempt and that the Aztec's tribute burden would be imposed therefore on only a certain percentage of the population. Actually this argument is not entirely defensible since the Aztecs were exacting tribute from states, not people and the ruler of that state was responsible for payment. How the ruler arranged the collection of this tribute among his dependents is not known and is really immaterial. The authors assume that the tribute was based on a rough population approximation and that it was based on the number of taxpayers of each conquered state--an assumption completely unwarranted. They then applied their estimates of the relative proportions of taxpayers to non-taxpayers in 1548 (and we have questioned their figures in this regard) to the population of taxpayers they calculate from the tax list to obtain a total population. Wholly aside from the fact that the actual size of the tax exempt class is not known for 1548, we have no proof that the relative proportions were the same in 1519. One could argue that the tax exempt classes were both larger and smaller in 1519 and it would be virtually impossible to prove it, one way or the other. In favor of a larger percentage would be the fact that the tax structure was Prehispanic in origin, was in conflict with Spanish objectives, and pressures from the Crown and encomenderos would result in a gradual reduction of the tax exempt class. On the other hand we have cited evidence to suggest just the opposite trend, that the Indian nobility attempted to increase their mayeque personnel at the expense of the free calpulli population.

(f) There are disagreements in the three sources as to the amount and frequency of tribute.

(g) Borah and Cook cite documentary evidence in reference to taxes paid to the natural lords by their dependents to suggest a standard tax rate. We agree. In all probability local taxes (within the local, legal, taxpaying state) were probably based on a census and the tax did relate to population. All statements by the Spaniards with respect to the imperial tribute however emphasize the inequalities of the system. The imperial tribute was just that - tribute, not in any sense a tax, was considered as an abuse by the tribute payers, and was based on a variety of factors as we have indicated. Granted, the tribute had to be within the capacity of the population to pay - but again we raise the question what is the capacity to pay?

In summary we feel that the population estimates of Cook and Simpson and Cook and Borah of the population in 1519 are based on extremely unreliable data and question the appropriateness of their methodology. In the next section of this chapter alternative possibilities for the population in 1519 will be discussed.

IV. THE POPULATION OF THE CENTRAL MEXICAN SYMBIOTIC REGION IN 1519 - A REEVALUATION

1. Methodology

In this section we will attempt to derive an estimate of the population of a portion of the area studied by Cook, Simpson and Borah for the year 1519. Our methodology will consist of the following steps.

All documentary evidence points towards a substantial population loss between 1519-1595. There are no dissenting 16th Century sources on this point. If one can establish with reasonable accuracy a population for the area at some time during the Postconquest portion of the 16th Century then this provides at least a minimal population for 1519. The earliest date for which this is true is 1568. The methodology will consist first of the establishment of the population for that year.

These figures will then be compared with modern censuses of the same area to test their reasonableness.

Thirdly we will utilize the relatively accurate 16th Century censuses that post-date 1568 and scattered and, what appear to be reliable, data from test areas prior to 1568 to establish a population curve. This curve will then be extended back to 1519.

Finally we will test these estimates by a more intensive examination of one small area, the Teotihuacan Valley. In this final step the approach will be multiple, 16th and 20th Century censuses will be used, Charlton's study of agricultural productivity for the region tested against the estimates, along with some archaeological survey data.

To recapitulate - Cook and Simpson established a population figure for all of Central Mexico of 4,409,180 for 1565. Cook and Borah revised these figures downward to 2,649,573 or approximately 2,650,000. They then qualified the figure suggesting a probable range of 2,500,000-2,800,000. This figure is reasonable accurate as are the estimates they calculate for the period subsequent to this time. A dependable population curve could then be established between 1565-68 and 1605-07. From their calculations we have estimated a population of approximately 1,000,000 for the Central Mexican Symbiotic Region in 1568.

For the period prior to 1568 their estimates are completely unreliable. If one assumes that the Suma census was accurate, and the paucity of corroborative censuses makes this assumption dangerous, then all that can really be said is that there were approximately 2,940,000 tax paying Indians and their dependents in Central Mexico in 1548. The Cook-Borah estimate by the utilization of the various formulae discussed would raise this to 6,300,000 to account for the tax exempt elements; their figures for the Central Mexican Symbiotic Region calculate at 2,500,000. The total percentage of tax exempt elements could have been as low as 20-30% however in the areas where mayeques were present. If this figure is used it would result in a population figure approximately between 3,530,000 - 3,820,000 for Central Mexico in 1548, disregarding the probability that mayeques

were absent as a class in many towns. For the Central Mexican Symbiotic Region the figure calcualtes at 1,500,000 - the recalculated figure would still allow for substantial population loss between 1548-1565 and yet would be far below the Cook-Borah estimates. We are not, however, insisting on these figures since we have already expressed our opinion as to the reliability of the earlier censuses.

We reject outright, both the figures and the methodological assumptions and procedures upon which they are based, Cook and Borah's estimate of the population of Central Mexico during the First Audiencia. Although the Cook-Borah 1548 estimate is high, a reasonable curve of population could be projected by utilizing it, back to 1532. Between 1532-1548 however they estimate a drop of from 16,800,000 to 6,300,000, and we are very skeptical of a loss of 10,000,000 people in a period of only 16 years. This figure of 16,800,000 for 1532 offered by Cook and Borah is a critical one since it would provide a minimal population for 1519, that is only ten years removed from that date, but we feel it is much too high.

2. The 1568 Population

As stated previously, the earliest reliable estimates of population offered by Cook and Borah date from the 1560's. In Table Four their data has been tabulated for the Central Mexican Symbiotic Region for that decade. In the table and subsequent discussion the cabecera districts have been grouped into larger units equivalent to the 20th Century judicial districts. This has been done to facilitate comparisons of contemporary censuses to those of the 16th Century. The contemporary municipios correspond only roughly or not at all to the 16th Century cabecera districts and the problem was to find a territorial unit large enough to reduce gross discrepancies in the size of the units being compared yet smaller in size than a modern state. The use of the judicial district was a happy compromise and it was relatively easy to equate 16th and 20th Century territorial units by this means. The judicial districts, furthermore, coincide rather well with ecological units.

The total population for the Central Mexican Symbiotic Region in the decade of the 60's, after forty years of decline, calculates at approximately 1,000,000 with an overall density of approximately 40 per square kilometer or 100 per square mile. In order to test the reasonableness of these calculations the population of the same area according to a number of 20th Century censuses is presented in Tables 6,7,8.

In comparison of the 16th Century and 20th Century censuses a number of precautions must be taken. Up until 1900 Mexico was still a predominantly agrarian state. Prior to this time the population size and density from area to area reflected primarily local ecological processes. Between 1900 and 1960 there has been an enormous growth in the population of Mexico City (from a half a million to five million) and the growth of the city has stimulated the growth of population throughout the Central Plateau, particularly in the Basin of Mexico. Many, one-time farmers, living in small communities have become industrial workers commuting into the city. In some areas commercial

Table 4

Population of Central Mexican Symbiotic Region in 1568

by 16th Century Tax Districts and 20th Century Judicial Districts

Basin of Mexico

Cuautitlan		
Coyotepec	1591	
Cuauhtitlan	9587	
Huehuetoca	5755	
Teoloyucan	2967	
Tepotzotlan	8900	
Tultitlan	4686	
		33,486
Chalco		
Amecameca	4976	
Chalco Atenco	1425	
Chimalhuacan-Chalco	2541	
Coatepec	3947	
Ixtapaluca	1805	
Tenango	8154	
Tlalmanalco	17642	
		40,490
Otumba		
Axapusco	3699	
Otumba	16368	
Oxtotipac	10907	
Teacalco	564	
Tecamac	1782	
Temascalapa	551	
Tlananalapa	2115	
Zacualpa	1974	
		37,960
Texcoco		
Acolhuacan	448	
Acolman	10085	
Chicoloapan	789	
Chimalhuacan	5854	
Huexotla	8250	
Tecoloapan	8234	
Teotihuacan	4689	
Tepetlaoxtoc	9867	
Tepexpan	1548	
Tequisistlan	1244	
Texcoco	25212	
		76,220
Tlalnepantla		
Chiconautla	1688	
Coatitlan	654	
Ecatepec	7333	
Tenayuca	2671	
Tlalnepantla	9587	
		21,933
Zumpango		
Apaxco	3814	
Hueypoxtla	8036	
Nextlalpan	2541	
Jilotzingo	1550	
Teotlalpa	5854	
Tequixquiac	6616	
Tlapanaloya	610	
Xaltocan	1518	
Zitlaltepec	1934	
Zumpango	6369	
		38,842
Xochimilco (Delegation)		
Milpa Alta	7852	
Mixquic	2363	
Tlahuac	3887	
Xochimilco	23166	
		37,268
Mexico City and Environs		
Azcaputzalco	5082	
Churubusco	1320	
Coyoacan	13629	
Culhuacan	2864	
Ixtapalapa	1972	
Mexicalcingo	621	
Mexico City	52000	
Tacuba	13266	
Tacubaya	2016	
Talasco	1521	
Tlatelolco	14982	
		109,273

Table 4 (continued)

Southern Hidalgo

Tula		
Atitalaquia	4673	
Atotonilco Chico	4735	
Axacuba	13398	
Michimaloya	4402	
Sayula	993	
Tetepango	1386	
Tlahuelilpa	2501	
Tepexi del Rio	11237	
Tlamaco	2244	
Tula	14593	
Xipacoya	6155	
Yetecomac	1047	
		67,364
Pachuca		
Acayuca	2288	
Epazoyuca	5481	
Ixquintlapilco	20988	
Pachuca	6079	
Texcatepec-Tuzan tlalpa	8663	
Tizayuca	3433	
Tlaquilpa	2402	
Tlilcuautla	2046	
Tolcayuca	2970	
Tornacuxtla	2330	
Zempoala	3571	
Zapotlan	1106	
		61,357

West Puebla - Tlaxcala

Huejotzingo		
El Verde - Salvador	1128	
Teotlalcingo	1128	
Texmelucan	2258	
Huejotzingo	26285	
		30,799
Cholula		
Cholula	35772	
Cuapan	13761	
		49,533
Atlixco		
Huequechula	10329	
Tepapayeca	4356	
Tochimilco	4521	
		19,206
Matamoros		
Tejoluca	141	
Tepexco	?	
Tatetla	924	
Epatlan	1907	
Necostla	320	
Chalma	677	
Coatepec	168	
Calmeca	358	
Tilapa	1225	
Izucar	5247	
Tonala	6336	
Moloacan	?	
Ahuatlan	112	
Teopantlan	1482	
		18,897
Tlaxcala		
Tlaxcala		165,000

Morelos

Cuernavaca, Tetecala (+ part of Juarez)		
Cuernavaca	39336	
Tetela	4227	
Tepoztlan	7498	
		51,061
Morelos (excluding Yecapichtla)		
Amilpas	4184	
Jumiltepec	3062	
Ocuituco	4458	
Tlacoltepec	1409	
Temoac	2260	
Huaculco	406	
Zacualco	706	
		16,485
Jonacatepec (including Yecapichtla)		
Yecapichtla	14240	
Tlayecac	726	
Anayuca	660	
Jantetelco	2680	
Jalostoc	627	
Jonacatepec	5640	
		24,573
Juarez (Portion only)		
Tlacuiltenango	13959	
		13,959

Table 4 (continued)

Yautepec + part of Juarez		
Yautepec	13352	
Tlayacapan	4241	
Totolapan	10659	
Oaxtepec	17870	
		46,122
Unidentified Locations		
Cuahuequasco	863	
Yalostoc	531	
		1,394

TABLE 5.

Summary of Population of Central Mexican Symbiotic Region, 1568

Unit	Population	Area (Km^2)	Density
Basin of Mexico			
Cuauhtitlan	33,486	589.54	55.94
Chalco	40,490	1605.53	25.22
Otumba	37,960	800.21	47.43
Texcoco	76,220	1099.85	69.30
Tlalnepantla	21,933	1019.31	21.52
Zumpango	38,842	733.91	52.92
Xochimilco	37,268	791.57	47.08
Mexico City, Etc.	109,273	621.90 (Excl. M.C.)	68.00 (Excl. M.C.)
	395,472	7405.74	53.40
Southern Hidalgo			
Tula	67,364	1451	46.43
Pachuca	61,357	1591	38.57
	128,721	3042	42.31
West Puebla - Tlaxcala			
Huejotzingo	30,799	890.21	34.59
Cholula	49,533	776.57	63.78
Atlixco	19,206	982.44	19.54
Matamoros	18,897	1703.30	11.09
Tlaxcala	165,000	2700-3000	55-61
	283,435	7052.52-7352.52	
Morelos			
Cuernavaca-Tetecala	51,061	1767.12	28.90
Yautepec-Juarez	60,081	1422.00	42.25
Morelos (Excl. Yec.)	16,485	1764.73	23.27
Jonacatepec (+Yec.)	24,573		
Unidentified	1,394		
	153,594	4953.85	31.01
TOTALS	961,222	22,494.11-22,794.11	

Table 6

Comparison of 1568 and 20th Century Censuses of the Central Mexican Symbiotic Region
(excluding the Federal District and Tlaxcala)

District	1900 Pop.	Density	1910 Pop.	Density	1930 Pop.	Density	1940 Pop.	Density	1950 Pop.	Density	1568 Pop.	Density	Area (Km2)
Cuauhtitlan	33,048	55.21	34,788	58.12	35,909	59.99	42,242	70.57	55,225	92.26	33,486	55.94	598.54
Chalco	69,478	43.27	71,930	44.80	64,566	50.21	79,656	49.61	96,767	60.27	40,490	25.22	1605.53
Otumba	36,213	45.25	35,155	43.93	30,716	38.38	33,809	42.25	36,221	45.26	37,960	47.43	800.21
Texcoco	58,921	53.57	56,547	51.41	66,078	60.08	78,196	71.10	97,600	88.74	76,220	69.30	1099.85
Tlalnepantla	61,486	60.32	60,302	59.16	64,250	63.03	80,851	79.32	125,097	122.72	21,933	21.52	1019.31
Zumpango	28,263	38.51	26,972	36.75	31,965	43.55	38,434	52.36	44,235	60.27	38,842	52.92	733.91
Pachuca	99,608	62.61	98,368	61.83	114,044	71.68	132,957	83.57	NO	DATA	61,357	38.57	1591.00
Tula	39,572	27.27	40,036	27.59	54,024	37.23	65,910	45.42	NO	DATA	67,364	46.43	1451.00
Atlixco	53,304	54.25	57,852	58.88	50,995	51.90	60,179	62.27	79,197	80.61	19,206	19.54	982.44
Huejotzingo	49,231	55.30	49,827	55.97	54,396	61.10	60,928	68.44	75,974	85.34	30,799	34.59	890.21
Cholula	49,325	63.51	51,150	65.86	60,897	78.41	68,794	88.58	85,219	109.73	49,533	63.78	776.57
Matamoros	37,573	22.06	40,456	23.75	36,676	21.53	42,748		50,982	25.10	18,897	11.09	1703.30
Tetecala	24,083	27.52	26,264	30.01	20,233	23.12	25,629	29.29	34,286	39.18			875.00
Cuernavaca	40,813	45.74	45,477	50.97	29,196	32.72	44,191	49.53	85,216	95.52	51,061	28.90	892.12
Juarez	20,233	21.82	24,769	26.71	18,300	19.74	25,814	27.84	40,422	43.60		42.25	927.00
Yautepec	18,336	37.04	20,240	40.88	13,212	26.69	16,568	33.47	22,839	46.13	46,122		495.00
Morelos	30,055	34.79	33,607	38.91	28,884	33.44	42,141	48.79	59,500	68.89		23.27	863.73
Jonacatepec	26,595	29.52	29,237	32.45	22,243	24.69	25,200	27.97	30,584	33.94	24,573		901.00

Table 7

Comparison of 1568 and 20th Century Censuses of Distrito Federal

Delegacion	1900 Pop.	Density	1910 Pop.	Density	Area 1900-1910	1930 Pop.	Density	1940 Pop.	Density	Area 1930-1940	1568 Pop.
Tlahuac	Included in Xochimilco					11,780	144.43	13,843	169.73	81.56	6,250
Xochimilco	42,610	208.57	30,093	147.30	204.30	27,712	210.90	33,313	253.52	131.40	23,166
Milpa Alta	9,415	33.98	16,268	58.70	277.10	12,608	46.81	14,786	54.90	269.32	
Tlalpan	12,522	39.44	15,448	48.60	317.50	15,009	48.53	19,299	62.24	309.29	7,852
	64,547	80.79	61,809	77.37	798.90	67,109	84.78	81,241	102.63	791.57	37,268
Azcaputzalco	10,785		14,419		37.50	40,098		63,000		84.14	
Coyoacan	7,189		13,230		57.70	24,266		35,248		62.26	
Cuajimalpa	6,857		5,193		87.10	5,406		6,025		70.92	
Ixtapalapa	10,440		24,507		161.60	21,917		25,393		119.60	
Mixcoac	10,661		21,812		28.80	Incorporated into Mexico City					
San Angel	15,975		16,734		95.20	22,518 (Obregon)		32,313		90.72	
Tacuba	9,226		36,087		13.90	Incorporated into Mexico City					
Tacubaya	20,177		37,552		65.10	Incorporated into Mexico City					
Guadalupe Hidalgo	16,761		18,344		75.00	Incorporated into Mexico City					
Gustavo Madero	Not yet separated							41,567'		75.60	
Ixtacalco	Part of Ixtapalapa					9,261		11,212		58.34*	
Magdalena Contreras	Not yet separated					9,933		13,159		67.70	
	108,071	173.77	187,878	302.10	621.90	133,399	240.93	227,917	407.23	553.68	66,982

* Reduced to 39.25 Km^2 in 1950

Mexico City not included in discussion

Table 8

Comparison of 1568 and 20th Century Censuses for Tlaxcala

Distritos											
Prehispanic Tlaxcala Cuauhtemoc	19,455	53.15	21,198	57.91	29,530	80.68	31,282	85.46	43,095	117.74	366
Hidalgo	39,213	87.92	41,532	93.12	43,706	97.99	48,324	108.34	62,591	140.33	446
Zaragoza	38,650	121.92	43,084	135.91	4,954	156.21	52,982	167.13	60,092	189.56	317
Sub total	97,318	86.20	105,814	93.72	78,190	108.73	132,588	177.43	165,778	146.88	1129
Rest of state (Fractions in parenthesis refer to portion included within Colonial Province)											
Juarez (2/3)	36,056	28.26	36,661	28.73	36,838	28.87	39,709	31.12	48,664	38.14	1276
Morelos (2/3)	18,662	22.40	20,615	24.74	17,379	20.86	18,969	22.77	22,415	26.90	833
Ocampo (1/2)	20,279	30.31	21,081	31.31	22,342	33.39	20,013	29.91	19,547	29.20	669
Unidentifiable as to Distrito					6,143		12,784		27,975		130
Sub total	74,997		78,357		82,702		91,475		118,601		4037
TOTALS	172,315	42.68	184,171	45.62	160,892	50.89	224,063	55.50	284,379	70.44	

Province 1568 - 2700-3000 Km^2 Population - 165,000 Density - 55.61 per Km^2

agriculture has replaced subsistence farming in response to the growth of the urban market. Most of this development, however, has occurred since 1930 so that the 1900-1910 censuses should still reflect a population distribution that was linked primarily with local ecology. Areas particularly affected by the urban growth of Mexico City were the districts of Cuauhtitlan and Tlalnepantla and all of the Distrito Federal except Milpa Alta, but perhaps no area in the Basin of Mexico has been unaffected. Urban growth of Puebla, Pachuca and Cuernavaca has undoubtedly had effects on population distribution in their immediate rural hinterland as well. Aside from the growth of major population centers lesser urban development in Jojutla and Cuautla in the state of Morelos, Atlixco and Matamoros in Puebla have all stimulated population movement and growth. The following comparative evaluation, distrito by distrito may be made.

Cuauhtitlan. The 1560 population corresponds very closely to the 1900 1910 and 1930 censuses. Since 1930 the population has climbed very rapidly, presumably in response to the growth of the factory complex at Cuauhtitlan and on the north slope of the Guadalupe range.

Chalco. All of the modern censuses show figures strikingly higher than those compiled by Cook and Borah. The density of 25.2 persons per square kilometer for the mid-16th Century is surprisingly low and at first sight we felt something was wrong. The clue is provided by document 546 in Volume 10 of the ENE where intensive investigations of tax abuses by Vasco de Puga demonstrates that the mayeque system was still actively functioning in Chalco as late as the 60's. He claimed that the official count of 13,000 tributaries could be increased to 20,000 if the mayeques were included. He also points out that the number of mayeques had steadily increased in the province since the Conquest.

Otumba. This area has apparently stabilized in population with very little increase between 1900 and 1950. The total range of the densities varies from only 38.8 to 47.3 per square kilometer. The 1560 density calculates at 47.43. For reasons to be elaborated later we feel that Cook and Borah have over-estimated somewhat the 1560 population of this district but our recalculated figure still falls close to those of the modern censuses.

Texcoco. The population of this district between 1900 and 1930 was approximately 2/3 that of Cook and Borah's estimate and the 1560 level was achieved only as late as 1940. Texcoco however contained a large Conquest Period city and contemporary Texcoco is a small town of between 8-10,000 inhabitants or substantially smaller than the Aztec town in 1519. Allowing for this urban decline therefore the rural population for 1560 was comparable to that for the period between 1900 and 1930.

Tlalnepantla. Contemporary Tlalnepantla has a population far in excess than that in 1560, and here the reasons are clear. Much of the urban expansion of Mexico City has been northward into this area and much of the population in recent censuses can be considered as urban in way of life. Furthermore, one suspects that in the 16th Century much of the land on the north and west shore of Lake Texcoco was controlled and utilized by people residing in Mexico City, leaving only a small area for a resident rural population.

Zumpango. The figures for the 1900-1950 censuses are all fairly close to those compiled by Cook and Borah for the 1560's. The lower figures for 1900-1910 may relate to the loss of the lake as an ecological resource with the difference being made up in the 1950 and 1940 censuses by urban occupations.

Xochimilco. The 1560 population figures are considerably lower than all 20th Century censuses for this portion of the Basin of Mexico (37,268 compared to 61,809-81,241). Since 1930 a substantial percentage of the population of the area has become urban in mode of life, people who live in the old peasant village but work in the growing metropolis. Even as late as 1900, when Mexico City still had a population of only about half a million inhabitants, however, the population was still 70% larger than was the case in 1560. Unlike Chalco, there is little reason for doubt as to the accuracy of the figures that Cook and Borah cite and they check closely with special investigations conducted by the Crown.

Mexico City and Environs. This is the area most drastically affected by 20th Century urbanization at the capital, and even as early as 1900 and 1910 much of the surrounding population was urban in mode of life. Of course this was true in the 16th Century as well; such towns as Coyoacan, Ixtapalapa, Azcaputzalco, and Tlacopan (Tacuba) were major urban communities linked by causeways to Tenochtitlan. Nevertheless, even excluding Mexico City from the comparisons, in this area were two and a half times as many people living in peasant communities in 1900 as compared to 1560.

Tula and Pachuca. The 1560 figure for southern Hidalgo compares very closely with the censuses from the 20th Century, if we exclude the city of Pachuca, as a mining and industrial center, from the picture.

Tlaxcala. For Tlaxcala there is no breakdown by areas, but only a total population estimate for the province for the 16th Century. The overall density calculates slightly higher than that for the 1900 and 1910 censuses for the same area as the modern state and is very close to the 1940-50 figures.

West Puebla. For the West Puebla area the districts have been sorted into two groups (excluding that which includes the City of Puebla) for comparison. Cholula and Huejotzingo form one group and contemporary densities approximate very closely those for middle of the 16th Century. Sixteenth Century Huejotzingo would be somewhat below contemporary figures and Cholula somewhat above but one cannot be entirely sure that the administrative borders were comparable to the modern distritos, and this difference may be more apparent than real. The population for Atlixco and Matamoros on the other hand is twice as high in recent censuses as for the mid-16th Century.

Morelos. The total population of the state of Morelos in the 1560's was very close to that in 1900, but with a somewhat different distribution. The 16th Century population was heavily concentrated in the northern half of the state, particularly in areas above the 1400 meter contour. This bias is still reflected in the 20th Century censuses but is considerably less pronounced.

Generally speaking then the 20th Century censuses, particularly the 1900-1910 censuses, approximate very closely the population figures given by Cook and Borah for the 1560's, with two major exceptions. One is an area located close to Mexico City where recent urban growth has resulted in a densely settled suburban strip with heavier densities in the 20th Century, the other is a band of settlement extending from Morelos into West Puebla and located between 1000 and 1400 meters above sea level, in other words, an altitudinal strip that lies below most of the area. In the Cook-Simpson-Borah studies they demonstrate conclusively that population decline occurred at a much faster rate in lower lying areas than in the uplands. The fastest and most catastrophic losses were in the tropical lowlands, in areas below 1000 meters above sea level. The major factors seem to have been the addition of malaria to the more generally distributed smallpox, measles, and whooping cough epidemics which caused frightful mortality in the lower areas. Their studies indicate that the decline of population in the coastal areas between 1519 and 1568 was seven times as fast as in the Central Plateau, and that the decline in areas of intermediate altitude was approximately twice as fast. We do not accept the actual rate of decline between 1519 and 1568 given by Cook and Borah but the ratios between the various ecological zones are probably approximately correct. If so then the much lower figure for the 1560's for the band between 1000 and 1400 meters above sea level is explicable.

In summary, our survey of recent censuses demonstrates that the population in the first half of the 20th Century, excluding the large urban centers and their immediate rural fringe, has been approximately the same as that for 1568. The major factors that have operated to keep the contemporary population below the 1519 level are as follows:

1. Postconquest deterioration of the environment as the product of sheet and gully erosion of slopes, loss of the lakes as a resource and of water resources for irrigation. The latter has been the product of erosion, drainage of the lakes and capture of water sources for urban centers.

2. Slow recovery from the epidemics of the 16th and 17th Centuries.

3. Social and economic institutions of the 17th, 18th, 19th and early 20th Centuries that resulted in a consolidation of small intensively cultivated holdings into large extensively cultivated ones, a process that retarded population recovery.

3. Earlier Censuses

By a combination of direct statements by Cook and Borah and ratios based on their data the population for the various levels of territory discussed in this study may be tabulated as follows:

Year	Central Mexico	Cook-Borah Area 1	C.M.S.R.	Basin of Mexico
1519	25,200,000	10,907,000	6,400,000	2,560,000
1532	16,800,000	7,992,307	4,600,000	1,840,000

1540	6,300,000	4,120,000	2,400,000	960,000
1568	2,650,000	1,707,758	1,000,000	400,000
1580	1,900,000	1,233,032	780,000	310,000
1595	1,375,000	770,649	450,000	180,000

In Fig. 4, page 454 the curve of decline for the Central Mexican symbiotic region is presented accepting the Cook-Borah estimates. Immediately apparent is the extraordinary steepness of the curve upward between 1519 and 1540. There is a slight deviation from a linear curve between 1565 and 1540 as well, but particularly dramatic is the shift during the early decades. This is all the more surprising since the first major epidemic occurred in the 40's, and an equally severe one occurred in the 70's. One would expect a slow decline between 1519 and 1540 and then a rapid increase in the curve of decline between 1540 and 1595.

We have compiled data for a number of areas that provide a much more reasonable picture of the rate of population decline between 1530-1580. One of the most consistent pictures emerges from Cholula and the data is summarized in Table 9.

Between the late 1550's and 1571 there are six separate estimates of population with a total range of variability of between 11,786-13,640 tributaries, a rather remarkable agreement. The data suggests furthermore considerable stability in population even though no less than 5 minor epidemics occurred during that span of time. (See Gibson 1964) Following the great epidemics of the late 1570's it dropped to 9,000 vecinos. In the Relacion de Cholula, written by Gabriel Rojas, a figure of 15,000 vecinos is estimated for the late 40's. The population for the same period given in the Suma de Visitas is 9,340 tributaries. Presumably the Rojas figure refers to the total population, tributary and non-tributary, which would suggest a non-tributary population of approximately 40% of the total, tributaries making up 60%. For earlier figures there is a statement in a document dating at 1531 (Volume XVI, E.N.E. Document 96) that the district had 20,000 hombres de guerra. If we assume an equivalence of casado with hombres de guerra the population had declined 25% between the two dates. For the Conquest period almost all statements derive from a figure given by Cortez. Cortez and his biographer cite a figure of 40,000 casas in the city and dependent territory. Rojas converts this to vecinos. Both figures would seem high if the 1531 population estimate is reasonably accurate. The total population assuming casas (and multiplying by a factor of 7) would be 280,000; assuming vecinos, the population calculates at 132,000 (3.3 conversion ratio). The figure for 1531 would be but 66,000 and we would have to assume a reduction in a ten-year period to either 1/2 or 1/4 of the Conquest figure to accept them. The rate of decline here seems extremely excessive. The figure of 280,000 would be closest to the curves plotted by Cook and Borah. There is one document that suggests a more conservative population figure. It is found in the E.N.E. Volume IV. This is a document dating from 1544 that states that the province once had 25,000 hombres de guerra. This could be a possible variant of the same 1531 figure or data referring to 1519. If the latter is assumed then a population for Cholula of 82,500 can be calculated for the time of the Spanish Conquest. These figures have

TABLE 9.

Population of Cholula (Province) During the 16th Century

Date	Comment	Source Data	Source	Calculated Pop.
1581	Following the 1576 Epidemic	9,000 vecinos	Gabriel Rojas	29,700
1571		13,640 pesos	C	38,192
1571		11,786 tributarios	N	33,021
1570		12,610 pesos	E	35,300
1568		12,000 vecinos	Codice Franciscano	39,600
1563		13,640 tributarios	ENE Vol. X Doc 545	38,192
1550's		13,000 tributarios	ENE Vol. XIV Doc. 825	36,400
1540's	Following the 1541 Epidemic	15,000 vecinos	Gabriel Rojas	49,500
1547-51	Tax payers counted only	9,340 tributarios	Suma de Visitas (Source A)	
1531		20,000 hombres de guerra	ENE Vol. XVI Doc 96	66,000
Sometime before 1544		25,000 hombres de guerra	ENE Vol. IV p.13	82,500
Sometime before 1558		25,000 tributarios	ENE	82,500
1519		40,000 vecinos	Gabriel Rojas	132,000

been plotted on graph number two. The curve very closely approximates the more conservative curve plotted in Figure 1 for Central Mexico, and again casts considerable doubt on Cook and Borah's estimates. It would seem highly unlikely that the district of Cholula had a population exceeding 100,000 in 1519.

Another district for which we have some reasonable estimates from early in the century is Tepoztlan. Cook and Borah calculate the population in 1595 at 4,890 and for 1568 they estimate 7,498. If Cook and Borah's curve for the Central Mexican area is correct, Tepoztlan should have had a population of 34,490 inhabitants in the 1530's. Carrasco reports an extraordinarily detailed house-to-house census that dates from 1537. In the case of the central town all residents were counted and their kin relationships even noted! The total population in 1537 was only 12,062. It is possible that the figure excludes children below 4 years of age - but even allowing for this the population was still only forty percent of that calculated from the Cook-Borah curves.

In the E.N.E. Volume XIV is a document, No. 825, undated, that may provide a key to calculations of early 16th Century population. The document is signed by Ochoa de Luyando who was apparently a census taker conducting a tax investigation for the Crown. The census covered a large area including the districts of Huexotzingo, Cholula, Tlaxcala, Chalco, Texcoco, Xochimilco, and the City of Mexico. The document has two sets of population figures, one pair for each district. One set of figures, with two exceptions (Mexico City and Tlaxcala) is approximately double the other. The higher figures are cited in the main part of the document. The lower figures occur as notations on the left margin. The form of the document is reproduced below using Huexotzingo as an example, to clarify the following discussion.

Tributarios. 25,000. Como parecera por la ultima cuenta que se hizo en esta cibdad de Guaxocingo los indios que se hallaron son once mil trecientos veinte y cinco. Don Luis de Velasco. (Rubricado).	Esta dos leguas del volcan el pueblo de Guaxocingo que tiene 25,000 tributarios: este renta a su majestad 8,000 hanegas de maiz, sacado el diezmo dellas vendese a tres reales montan 2,700 pesos de oro comun: podria tributar sin vejacion, quitandoles como arriba esta dicho los otros tributos y derramas y no dando cada tributario mas de ocho reales de plata y' media hanega de maiz que es el menor tributo que se paga en los pueblos de los encommenderos, 29,337 pesos 4 tomines de oro comun.	Lo que tributan 2,700 ps.	Lo que podrian tributar 29,337 ps. 4 tom.

The lower figure, it will be noted, has a signature of Don Luis Velasco at the end. The figure for Huejotzingo is the only exact figure of the set and a total of 11,325 is almost exactly the figure of 11,318 cited by Cook and Borah for the 1558 investigation of the town. The smaller population figure on the left signed by the Viceroy then clearly refers to the decade of the '50's' and was part of the investigation we noted during the final years of Velasco's administration.

This raises the question as to the origin of the larger figures. They almost certainly refer to some earlier census. The document gives the actual tax paid by the district and suggests the amount that could be paid with a uniform head tax. The taxes paid relate definitely to the period of the Second Audiencia, for example, Chalco's tax is given at 8,000 fanegas of maize which was the Second Audiencia tax assessment for this town. The problem is, to what date do the population figures refer ? The figure cited for Cholula, 25,000 tributaries, Huejotzingo, 25,000 tributaries are very close to figures of 20,000 to 30,000 hombres de guerra cited for the same districts in Document 96. The sense of Document 825 seems to be that Luyando had made a population estimate of the various districts in the '50's' based on the earlier Second Audiencia census, and that Velasco's investigators revealed a considerably lower figure, presumably the product of population decline between 1531 and 1560. If we make this assumption then we have a major source for which to plot population decline between the two dates. The data is particularly important since it involves a large population and territory and not a single tax district as in the cases cited above. The data for this document may be summarized as follows:

Province	1530-35 Population (tribs)	1555-60 Population (tribs)	Cook - Borah 1568-Total Population
Chalco	45,000	22-23,000	40,490
Cholula	25,000	13,000	35,772
Texcoco	25,000	12-13,000	25,212
Xochimilco	20,000	12-13,000	31,018
Huexotzingo	25,000	11,325	26,285
Total Calculation	140,000 x 2.8 = 392,000	70,325-73,325 x 2.8 ≐ 196,910-205,310	158,777
Tlaxcala	50,000(140,000)	50,000 (140,000)	165,000
Mexico City	20,000(56,000)	20,000 (56,000)	52,000

The figures from Tlaxcala and Mexico City have been separated because they do not vary for the two censuses. In summary, if we assume that the larger figures refer to the Second Audiencia censuses then the five districts (excluding Tlaxcala and Mexico City) had a population of approximately 400,000 in 1530-35, and declined to 200,000 by the late 1550's and declined further to approximately 160,000 by the late 1560's. If the curves of decline plotted from these test cases are correct, then it seems likely that the 1530-35 population of those areas in Central Mexico above 1500 meters above sea level (all but Tepoztlan were above 2000 meters) was between 1.5 and 3.0 times that for 1568. Cook and Borah estimate a ratio of 4.6 to 1. The best data is from Cholula which would suggest either a 1.8 to 1 or 2.0 to 1 dependent on whether the 1530-35 population was 20,000 hombres de guerra or 25,000 tributaries. The large sample from the E.N.E. Document 825 yields a ratio of 2.5 to 1. We would therefore suggest that the population of the high elevated portions of the Central Mexican Symbiotic Region in the 1530's was between 2 to 2 1/2 times that for the 1560's with the exception of Tlaxcala and Mexico City. We also suggest that Cook and Borah's

assumptions that the population in the 1000 to 1500 meter band declined at approximately double the rate of areas above 1500 meters is correct. If these assumptions are accepted then the 1530 population tabulates as follows:

Area	1568	1530-35	Ratio
Basin of Mexico (excluding M.C. and environs)	294,535,-297,035	589,070-742,588	(2 to 2.5)
Southern Hidalgo	128,721	257,442-419,613	(2-2.5)
West Puebla-higher elevations	82,400	164,800-206,000	(2 to 2.5)
West Puebla-intermediate elevations	38,103	152,412-190,515	(4-5)
*Morelos	153,599	460,797-614,396	(3-4)

*We have used an intermediate ratio here since about 1/3 of the state lies above 1400 meters, the rest below it.

Mexico City presents a number of problems. The City in 1568, following Cook and Boran, had 52,000 inhabitants and the attached ward of Tlatelolco, 14,982, or a total of 66,982 inhabitants. It is not entirely clear in Document 825 whether the figure of 20,000 tributaries includes Tlatelolco but it probably does not. At any rate this figure of 20,000 is repeated for the earlier period indicating population stability during the span of time between 1531-1568. On the other hand, the census data for the communities on the immediate lake shore suggest a much faster rate of decline than in most areas at that elevation. Ixtapalapa in 1568 for example had a population of only 1,972, Mexicalcingo 621, Churubusco 1320, and Azcaputzalco 5,082. (Cook and Borah). Although Cortez's absolute figures for the Conquest are unacceptable the fact that he assignes Ixtapalapa 16,00 houses, Churubusco 3-4,000, and Mexicalcingo 3-4,000 as compared to Tenochtitlan's 60,000 would indicate a considerably higher population in 1519 than our graph projections would suggest. In all probability two factors operated to produce the rapid decline of lake shore settlements around Tenochtitlan. First, the city itself was characterized by population stability. This could only have been the case if there was a relatively heavy immigration from nearby settlements. Secondly, the denseness of settlement in the City and nearness to the lake shore and the fact that it was a center of Spainsh control would engender a more rapid spread of epidemic diseases in contrast to rural areas with smaller or more widely spaced settlements. We have therefore excluded the Tenochtitlan area in the chart. Document 825 and the other data would suggest population stability for the city between 1530 and the later decades of the Century with a fluctuation of no more than between 60-80,000. With respect to the lake shore communities, all one can say is that the decline was obviously much faster than in the plateau generally. If most of the loss in the smaller communities was the product of immigration into the city rather than differential disease rates, then a projected figure of 2 to 2.5 times 109,273 could be calculated for 1530-35 or 218,546-273,183 for Mexico City and the adjacent lake shore areas.

For Tlaxcala the problem is more complicated. First there is the problem of the expansion of the territory of the Tlaxcalan province from a preconquest area of only 1200 square kilometers to a Colonial province measuring between 2700 and 3000 square kilometers. It is not known precisely when the latter size was achieved or by what stages, but by the 1560's the expansion was complete. Population data between 1531-1596 therefore do not refer to the same territory. Gibson presents a table of population data from various sources. The figure of 50,000 tributaries is commonly cited for the period between 1531-1571 or its equivalent of 150,000 confessees (4 different sources). Another source for 1569 cites 40,000 vecinos (which is approximately equal to 50,000 tributaries), and another cites 34,322 in 1557. The province was never carefully censused and the figures are clearly approximations except for the figure of 34,322 which is an Indian census and includes only 75% of the province. This would suggest that the population of Tlaxcala between 1531-1571 clustered very closely to a total population of 140,000. Cook and Borah estimate 165,000. Along with these moderate estimates Gibson cites three other sources with population figures; ranging between 80,000 and 100,000. Ochoa de Luyando in Document 825 was also aware of a 100,000 estimate but rejected it. Gibson feels that these three sources were biased but that they might conceivably refer to earlier censuses. More probably the population did remain constant and this was the product of two processes that apparently counteracted the effects of epidemics. First, the gradual increase of territory probably helped to make up losses. It is interesting that after 1571 the absolute population did decline to 24,000 tributaries in 1583, 16,000 in 1593, and 15,000 in 1596. A second process was migration into the province from outlying areas and stimulated by the relatively light taxation exacted from the Tlaxcalans as a reward for services during the Conquest. The province was free of encomiendas, was a Crown possession and taxed at a rate of only 8,000 fanegas of maize per year. In summary the relationships between the 1568-1531 population in the Central Mexican Symbiotic Region tabulates as follows:

	1568	1530-35
Basin of Mexico (Excl. Mexico City)	294,535-297,035	589,070-742,588
Mexico City and Environs	109,273	218,546-273,183
West Puebla - above 2000 meters	82,400	164,800-206,000
below 2000 meters	38,103	152,412-190,515
Morelos	153,549	460,797-614,396
Tlaxcala	140-165,000 (area 2700-3000 Km^2)	140-165,000 (area 1200 Km^2)
Southern Hidalgo	128,721	257,442 - 410,613
TOTAL	946,581-974,081	1,980,067 -2,602,295

The population of the Central Mexican Symbiotic Region then calculates at between 2-2 1/2 million for 1530-35 and the density at 80-100 persons per Km^2. If Cook and Borah's estimates for the population between 1568-1595 are combined with our recalculations for 1540 and 1532 and the resultant curve of decline projected back to 1519, then the population of the Central Mexican Symbiotic Region in the 16th Century can be summarized as follows:

	Area Km2	Pop. - 1568	Pop. 1530-35 2-2.5 Ratio	Pop. 1519 2.7-3.0 Ratio	Density 1519 per Km2
Basin of Mexico					
Cuauhtitlan	589.54	33,486	66,972- 83,715	90,412-100,458	153.36-170.40
Chalco	1605.53	61,600-64,400 (1)	123,200-161,000	166,320-193,200	103.59-120.33
Otumba	800.21	25,186 (2)	50,372- 62,965	68,002- 75,558	84.98- 94.42
Texcoco	1099.85	76,220	152,440-190,550	205,794-228,660	187.11-207.90
Tlalnepantla	1019.31	21,933	43,866- 54,832	59,219- 65,799	58.10- 64.55
Zumpango	733.91	38,842	77,684- 97,605	104,873-116,526	142.90-158.77
Xochimilco	791.57	37,268	74,536- 93,170	100,623-111,804	127.12-141.24
Mexico City-Etc.	621.90	109,273	218,546-273,182	295,037-327,819	474.41-527.12
Sub total	7261.82	403,808-406,608	807,616-1,017,019	1,090,280-1,219,824	150.14-167.98
Southern Hidalgo					
Tula	1451.00	67,364	134,728-168,410	181,883-202,092	125.35-139.28
Pachuca	1591.00	61,357	122,714-153,392	177,664-184,071	111.67-115.70
Sub total	3042.00	128,721	257,442-321,802	359,547-386,163	118.19-126.94
Upper Atoyac Basin					
Huejotzingo	890.21	30,799	61,598- 76,997	83,137- 92,397	93.39-103.79
Cholula	776.57	49,533	99,066-123,832	133,739-148,599	172.22-191.35
Sub total	1666.78	80,332	160,664-200,829	216,876-240,996	130.12-144.59
Tlaxcala	3000 (1568) 1200 (1519-35)	165,000	140-165,000 (special case)	200-250,000(Special case)	166.67-208.33
Nejapa Basin				Guess estimates	
Atlixco	982.44	19,206	76,824- 96,030	225-300,000	101.79-127.23
Matamoros	1703.30	18,897	75,588- 94,485	165-205,000	58.71- 73.39
Sub total	2685.74	38,103	152,412-190,515	590,000-755,000	74.47- 93.08
			3-4 Ratio		
Morelos				Guess Estimates	
Cuernavaca Tetecala	1767.12	51,061	153,183-204,244	200-250,000	113.18-141.47
Yautepec-Juarez	1422.00	60,081	180,243-240,324	225-300,000	158.23-210.97
Morelos-Jonacatepec	1764.73	41,058	123,174-164,232	165-205,000	93.50-116.17
Sub total	4953.85	152,200	456,600-608,800	590,000-755,000	119.099-152.41
TOTALS	19,652.19		1,974,734-2,503,965	2,656,703-755,000	135.19-157.84

(1) Corrected from Cook, Borah (see p. 40)

(2) Corrected from Cook, Borah (see p. 50, table 4)

Table 10 - Population of Central Mexican Symbiotic Region During the 16th Century

IV. THE POPULATION OF THE TEOTIHUACAN VALLEY - PAST AND PRESENT

In this chapter we will analyze in more detail the population of the Teotihuacan Valley, our primary area of consideration. We will attempt to establish a probable total population for the year 1519, a curve of population decline for the 16th Century, compare the 16th Century population with that of the 20th Century census and finally to discuss patterns of population distribution with regard to ecological zones and communities for the 16th and 20th Centuries.

1. Contemporary Population

Complicating the problem of ascertaining the population size of the valley is the fact that population censuses are recorded by municipio and municipal boundaries correspond approximately or not at all to the limits of the hydrographic basin. The modern census data is summarized in Table 11 in the paper by Diehl. Each municipio consists of an administrative center called a cabecera and subject settlements variously referred to in the census as pueblos, barrios, ranchos, rancherias, ejidos, haciendas, estaciones, campomentos, granjas, colonias. (See the paper by Diehl with a discussion of these settlement types). The survey area comprises approximately 650 Km2 (including a section of the north slope of Cerro Gordo outside of the hydrographic basin). In 1910 this area had a population of approximately 33,000, by 1960 this figure had ascended to over 57,000.

2. 16th Century Population

Table 11 presents all of the data we have been able to collect on the population of communities within the Teotihuacan Valley in the 16th Century. There are considerable problems in the collation of data to achieve reasonably accurate figures for the various points in time. A major problem is that the jurisdictions of the cabeceras constantly shifted in size during the century; Tepexpan for example had 10 estancias in the Suma, 13 in the Relacion Geografica, Acolman six and twenty-seven respectively. A second problem is the incompleteness of the records and finally there are disagreements even with respect to the later censuses. The data is summarized in Table 11.

TABLE 11.

16th Century Censuses of the Teotihuacan Valley

	Document	Date	Area Involved	Population
Tepexpan	(T) Suma de Visitas	1547-51	Cab. & 10 Estancias	965 tribs.
	(T) Source B (E.N.E. Vol. 9, p. 2-48)	1560		850 pesos
	(E) Source H	1569-71		543 tribs.
	(T) Source L (E.N.E. Vol. 16, Doc. 831	1563	Temascalapa	1579 tribs.
	(G) P.N.E.	1580	Cab. & 13 Estancias	950 tribs.
Temascalapa	(E) K (Arzobispado de Mexico)	1570	Cab.	197 tribs.
			(Sujetos within survey area)	392 tribs.
Tequisistlan	(T) Suma de Visitas	1547-51	Includes Totolcingo	235 vecinos
	(T) B (E.N.E. Vol. 9, p. 2-48	1560	Includes Totolcingo	220 pesos
	(E) H	1569-71	Includes Totolcingo	422 pesos
	(T) E	1573	Includes Totolcingo	462 pesos
	(T) C	1571		
	E.N.E. Vol. 16 Doc. 821	Prob. 1569-71+	Estancia of Coaltzingo	422 tribs.
	E.N.E. Vol. 13 Doc. 745	1596	?	276 tribs.
Acolman	(T) Suma de Visitas	1547-51	Cabacera & 2 Nearby Estancias	1324 tribs.
			4 other Estancias	293 tribs.
	(T) B (E.N.E. Vol. 9 p. 2-48)	1560	"Pueblo" (Cook-Simpson)	1000 pesos

TABLE 11 (Cont'd.)

	(E) H	1569-71	"Pueblo" (Cook-Simpson)	1414 tribs.
	(E) H	1569-71	"Province"	2564 tribs.
	(E) K	1570	"Province"	2560 tribs.
	(G) N (Velasco census)	1571	"Province"	4100 tribs.
	(E) E.N.E. Vol. 16 Doc. 831	Prob. 1569-71	"Province"	2564 tribs.
			"Cab" (including nearby sujetos)	1404 tribs.
			Sujetos Atla	360 tribs.
			Chiapa	600 tribs.
			Zacatepec	280 tribs.
	(G) P.N.E.	1580	Cab. & 27 Estancias	1990 tribs.
	E.N.E. Vol. 13 Doc. 745	1596	? Probably same area as P.N.E.	1221 tribs.
Teotihuacan	(T) Suma de Visitas	1547-51	?	690 tribs.
	(T) B	1560	?	1400 pesos
	(T) L	1563	?	1655 tribs.
	(T) E	1573	?	1703 pesos
	(E) Codice Franciscano	1570	Cabecera & 8 Iglesias de Visita	2000 vecinos
	(G) P.N.E.	1580	Cabecera & 17 Estancias	1600 tribs.
	E.N.E. Vol. 13 Doc. 745	1597	?	1027 tribs.
Chiconauhtla	(T) B	1560		330 pesos
	(T) C	1571		528 pesos
	(T) E	1573		528 pesos

TABLE 11 (Cont'd.)

	(E) Codice Franciscano	1570		500 vecinos
	(G) P.N.E.	1580		440 tribs.
Tezoyuca	(E) Codice Franciscano	1570	With 2 Sujetos (part of Texcoco)	600 vecinos
Otumba	(T) B	1560	?	1600 pesos
	(T) C	1571	?	6184 pesos
	(T) E	1570	?	5042 pesos
	(G) N	1571	?	6500 tribs.
	(E) Arzobispado de Mexico	1570	Cabecera & 29 Sujetos, includes Oxtotipac & Axapusco	6472 vecinos
	(E) Codice Franciscano	1570	Cabecera & 20 sujetos; Axapusco & 1 sujeto; Oxtotipac & 3 sujetos	4000 vecinos 700 vecinos 700 vecinos
Axapusco and Zaguala	(T) B	1560		940 pesos
	(T) C	1571		1929 pesos
	(T) E	1570		695 pesos
	(T) P	1597		334 tribs.
	(E) Codice Franciscano	1570	+ 1 Sujeto	700 vecinos
Oxtotipac	(T) B	1560	?	600 pesos
	(E) Codice Franciscano	1570	Cab. & 3 sujetos	700 vecinos

If the data is converted into total population, based on the Cook-Borah formulae, it tabulates as follows:

	1547-51	1560	1563-71	1580	1596
Tepexpan	3184	2805	4421 + Temascalapa 2699 Alone	2660 (including Temascalapa)	
Temascalapa			1722		
Tequisistlan	775	666	1182-1294		773
Acolman	5336	3300	7169 partial count 11480 complete count	5572	3419
Teotihuacan	2277	4620	4768 6600	4420	2876
Chiconautla		429	1478	1232	
Tezoyuca			1980		
Otumba & Axapusco & Oxtotipac		10080	21358 18200 17315		

Tepexpan. The Suma population (tributaries counted only) for the cabecera and ten estancias was 965 tributarios. Source B, a tax list dating from 1560, cites 850 pesos tax with no data on the number of estancias. Source L, a tax document dating between 1565-70, gives a figure of 1579 tributaries. Between 1560-65 Tepexpan shifted in status from an encomienda to a Crown colony and its jurisdiction was at the same time expanded to include Temascalapa and other dependent settlements. We have been unable to find a parallel tax document that separates Temascalapa from Tepexpan but an ecclesiastic census for 1570 (Arzobispado de Mexico) assigns 615 tributaries to Temascalapa and its subject communities. This would yield a balance of 964 for Tepexpan and its other subject settlements for 1565-70. Cook and Borah cite a figure of only 543 tributaries from an Augustinian ecclesiastic tax list (Source H) for 1569-71. In this case however the figure probably refers only to Tepexpan and a few estancias located a few kilometers from the cabecera that were under direct Augustinian control. Finally the 1580 Relacion Geografica provides a figure of 950 tributaries in the cabecera and 13 estancias. This is approximately the same district censused in Document L. In summary Tepexpan and Temascalapa had a population of 1579 tributaries in the 60's which had declined to 950 by 1580. The cabecera itself probably had a population of approximately 400 tributaries in the 60's.

Temascalapa. See Tepexpan.

Tequisistlan. The Suma figure for Tequisistlan is 235 vecinos, again including only tax payers. The district was unmodified throughout the 16th Century - including the cabecera and only one estancia, Totolcingo. Document B dating from 1560 assigns only 220 pesos tax - apparently the abolishment of tax exemptions had not yet affected the community. Other censuses dating between 1560-71 vary slightly and assign from 420-462 pesos or tributaries to the town. The Relacion Geografica does not give a population figure but Document 745 (EN.E.) dating from 1596 assigns 276 tributaries.

Acolman. The Suma census assigns Acolman 1324 tributaries in the cabecera and two nearby estancias and an additional 293 tributaries to four others located further away. In 1580, the date of the Relacion Geografica, the cabecera had a district that included 27 estancias. Nearly all of the other censuses are ecclesiastic and include only the cabecera and those estancias served by the Augustinian monastery not the entire civil tax district, making comparisons difficult. Document H assigns 1404 tributaries or 3740 confessees to the cabecera; 360 and 960 respectively to Atlatongo, 600 and 1600 to Chiapa, 280 and 500 to Zacatepec; with a total of 2564 (sic) and 6840. Document K corroborates these figures. Document B, dating from 1560, assigns only 1000 pesos tax to the cabecera; the exemptions were apparently not yet abolished at Acolman either. One census for the 60's and 70's, (Document N - Velasco's 1571 geographical survey), probably includes a district comparable to that of the Relacion Geografica. It gives a figure of 4100 tributaries for the "province." The 1580 figure is 1990 tributaries. Finally a civil tax document (Document 745) for 1596 assigns 1221 tributaries.

In summary then we have three complete censuses for Acolman, 4100 tributaries in 1571, 1990 in 1580 and 1221 in 1596.

Teotihuacan. The data is very unsatisfactory for Teotihuacan. The Suma partial census cites a figure of only 690 tributaries. In 1560 one encomienda tax census cites a figure of only 1400 pesos - clearly not a complete census since Document L (1563) provides a figure of 1655 tributaries, and another (Document E), dating for 1573 cites a tax of 1703 pesos. The Franciscan Codex, an ecclesiastic

census, states that the cabecera and 8 estancias had a population of 2000 vecinos. Using the Cook-Borah formulae the number of vecinos should be less, not more than the number of tributaries. In 1563 Teotihuacan was still an encomienda community, by 1570 it had reverted to the Crown and possibly the encomienda - Crown tax district was smaller than the ecclesiastic district. By 1580 the tax district had grown to 17 estancias with a total population of 1600 tributaries. The same district had 1027 tributaries by 1597. The data strongly suggests that the censuses prior to 1580 refer to a much smaller jurisdictional territory.

Chiconauhtla. The data for Chiconauhtla is by comparison uncomplicated. In 1560, 330 pesos of tribute are reported by Document B and the community was, like Acolman, Tepexpan and Tequisistlan, not yet affected by the tax reforms. Two more tax documents for 1571 and 1573 (C and E) both cite a figure of 538 pesos tax. The Franciscan Codex assigns 500 vecinos to the community. By 1580 the population had declined to 440 tributaries.

Tezoyuca. This community presents special problems. Although a cabecera it was part of Texcoco's extended tributary district and separate tax censuses are unavailable. The Franciscan Codex assigned it and its two estancias (Nexquipaya and Ixtapan) 600 vecinos.

Otumba. The 1560 Document B reported only 1600 pesos tax. For 1570,71 there are five separate censuses, 2 are tax lists, 2 ecclesiastic censuses and one is Velasco's geographic survey. The civil tax lists (Document E and C) report taxes of 5042 and 6184 pesos respectively - a wide discrepancy. Velasco reports 6500 tributarios in 1571. The Arzobispado de Mexico census for 1570 reported 6472 vecinos. The Codice Franciscano seems to clarify somewhat these discrepancies. It reports 4000 vecinos in the cabecera and 20 "iglezuelas" and adds that Axapusco and one sujeto had 700, Oxtotipac and three sujetos 700 or a total of 5400 in all. Both Axapusco and Oxtotipac had parroquia churches but were considered as sujetos of the larger parroquia church at Otumba. The Arzobispado document simply lists the two as sujetos and assigns Otumba a total of 29 sujetos - three more than the total of subject communities given by the Franciscan Codex. The three additional sujetos could have had a total population of 1000 vecinos thus explaining the discrepancy between the two ecclesiastic censuses.

The civil tax lists for 1570 excluded Oxtotipac and Axapusco, since they were separate districts. Axapusco and its sujeto Zaguala are assigned 695 pesos tax by Document E, approximately the population given by the Codice Franciscano. We have no data on the Oxtotipac tax.

In summary, the Velasco, Codice Franciscano and Arzobispado documents all include Otumba, Oxtotipac and Axapusco and assign a figure of around 6500 vecinos or tributaries for 1570. The two tax documents refer to a smaller district that excludes Oxtotipac and Axapusco and vary from 5042-6184 pesos - a wide and unexplained discrepancy. The only data we have for a later period is a figure of 334 tributaries for Axapusco and Zaguala for 1597 (Document P).

With so much missing data we are forced to apply a system of ratios based on the rate of decline for those cases for which data is available. This is feasible only for the period after 1560 since all censuses prior to this are partial (including only tributaries). The ratio of the 1563-71 population to that for 1580, based on Tepexpan, Acolman and Chiconauhtla is approximately 17:9 or 2:1. The ratio of the 1580 to the 1596 population, based on Acolman and Teotihuacan is 10:6. If these ratios are applied to those communities with missing census data the following tabulation emerges.

	1563-71	1580	1596
Tepexpan and Temascalapa	4421	2660	1596
Tequisistlan	1182-1294	596-647*	773
Acolman	11480	5572	3419
Teotihuacan	8960	4480	2876
Chiconauhtla	1478	1232	739
Tezoyuca	1980	990	594
Otumba, etc.	17315-21358	8657-10679	5194-6407
	46816-50971	24187-26260	15191-16404

NOTE: Underlined numbers are estimates based on the ratios. *This number is obviously incorrect apparently because the population decline was much less in this town.

The population of the survey area then tabulates at about 50,000 in the late 60's, 25000 in 1580 and 15000 in 1596. If the Cook-Borah ratios were applied from the Central Mexican Region as a whole the population should have been 120,000 in 1548, 230,000 in 1532 and 320,000 in 1519. Our calculations would assign 75,000 in 1548, 100-125,000 for 1530-35 and 135,000 for 1519.

3. Agricultural Productivity

The population of the valley in 1580 was very close to that in 1910. The 1950 population was almost identical to that of 1563-71. In 1960 the population of approximately 55,000 exceeded all of the censuses dating from the last half of the 16th Century. These comparisons, although they do not necessarily demonstrate that our calculations of late 16th Century population are correct, do make them plausible. What of our projection for the first half of the 16th Century? Could the valley have supported a population of 75,000 in 1548, 100-125,000 in 1530, and 135,000 in 1519? Are Simpson Cook and Borah's much higher estimates possible in terms of the agricultural potential of the valley? We will now proceed to test these calculations on the basis of our data on agricultural productivity.

In order to do this, a number of basic assumptions must be made. First, we must assume that most of the food supply, at least the staples, were produced locally and that only small quantities were imported. All surrounding areas were at least as densely settled as the Teotihuacan Valley in 1519, and what surpluses were produced in those areas were more likely to have been channeled into major population centers like Texcoco and Tenochtitlan, rather than to markets in the small towns of the Teotihuacan Valley. In fact, one could more reasonably argue that the valley was essentially a rural, sustaining area for the major population centers and was, therefore, a producer and exporter of food surpluses.

Secondly, we must assume that the productivity of local races of maize used in the 16th Century was comparable to that of races in use today. The little data available on maize evolution in Central Mexico indicates that races comparable to those in use today were present in Postclassic times.

Thirdly, we must assume that agricultural techniques in 1519 were at least as effective and the agricultural system as productive as those in use today. Some writers have, indeed, suggested that Prehispanic agriculture was less productive than that in Posthispanic times. Kroeber argues this in his assessment of Mesoamerican population, as a whole, when he states:

> All these ratios are no proofs: but they do suggest that if our figures up to this point have been tolerably reasonable, the allowance of 3 million for cultural Mexico is also reasonable and perhaps liberal. The actual population in 1500 A.D. may have been more, but it may also have been less... but the illustration shows that we may not infer from present-day populations to native large ones. And to assume that there was a large population, that this was reduced to a mere small fraction by the Conquest, and that then it built itself up again, is gratuitous. The Conquest, no doubt, did cause a shrinkage in numbers; but in the well settled region this effect seems to have been transient and probably began to be made up by an increase attendant on the new experience of internal peace under Spanish colonial government. (A.L. Kroeber, 1947, p. 159-160).

Gamio (1922 English abridgement) made a statement with similar implications:

> The artificial production of this region, which comprises domesticated animals and vegetables, obtained by cultivation was doubtless much smaller prior to the Conquest than during the Colonial Epoch or the present time.

We disagree completely with this position. The introduction of winter wheat has increased the productivity of the Lower Valley by extending the growing season and permitting double cropping. This is, however, the only new plant that has directly affected productivity. Other crops simply replaced Prehispanic ones in the same areas. We see no reason to assume a priori that the introduction of the plow resulted in higher yields. The plow simply enables the farmer to cultivate more land, increases the production per family, and therefore elevates his standard of living. It does not necessarily result in an increase of population density or regional productivity. On the contrary, plow agriculture encourages extensive, rather than intensive, methods of cultivation. It may actually result in a decline of production per unit of land planted, as contrasted to hand tillage. (note the shift from cajete to al tubo planting in recent times). The densest rural population today occurs in portions of the Far East, where hand tillage is characteristic. Of course, if such hand cultivation were not accompanied by irrigation or terracing in Prehispanic times, the result would have been a low productivity. Evidence of such techniques is conclusive for the Aztec period. One factor that conceivably might have resulted in lower yields in Aztec times is the lesser significance of domestic animals in Prehispanic economy, and fertilizers were therefore exceedingly scarce. Today, fields are kept in continuous cultivation by periodic application of animal fertilizers. However, there are a number of facts which make us tend to disregard this consideration. First, the application of fertilizer today is neither general, consistent, nor regular. Second, the Prehispanic combination of calmil cultivation and terracing; more extensive use of irrigation, particularly

floodwater irrigation would have made up for the deficiencies of animal fertilizers. All in all then the Prehispanic situation with respect to productivity did not differ strikingly from that today.

We lack good data on agricultural techniques and production for the Upper Valley. The following classification of the capacity of the valley with respect to agriculture, therefore excludes this area.

Steep Slope and Mountain Areas:	km^2
Cerro Gordo	40
North Side, small hills	10
Patlachique and southeastern ranges	50
	100

Deep Soil Alluvial Plains:	Km^2
Lower Valley-Delta	40
Middle and Upper Valley	30
	70

Gentle to Medium Slope - Good Conditions for Terracing and Floodwater Irrigation:	
Cerro Gordo Piedmont	60
South Piedmont	30
	90

Gentle to Medium Slope-Poor Conditions for Floodwater Irrigation or Terracing:	
North Piedmont	80
TOTAL	340 Km^2

The alluvial plain of the Lower Valley and Delta comprise 4,000 hectares of land, or 40 km^2. Of this, 3,600 are classified as irrigated land today. In fact, as Charlton has noted, the declining yield of water from the springs has reduced the efficiency of the system. He also noted a considerable range of productivity between the lands of Atlatongo and Calvario Acolman (average yield from 1875 kgs to 1350 kgs). If we assume that the water output from the springs was 50 percent higher in 1519, as the recent declining yield of water suggests, then one could either apply the Atlatongo average yields to the 3,600 hectares under irrigation today or assume that the same pattern of pressure and competition for water operated in 1519 to spread the supply out over a larger area, say 5,400 hectares and use the Calvario Acolman average, (this figure however would include some land outside the valley in the Texcoco plain). There is the problem, of course, of the lower supply of fertilizers that complicates the picture. Considering all of these factors, we will assume continuous land use over the 5,400 hectares that comprises the Lower Valley, Delta and adjacent northern portions of the Texcoco plain and an average yield of around 1400 kgs. The average ration of maize per year, assuming an 80 percent dependence of maize in the diet, would be around 200 kgs per individual per year. This means that a hectare of land would feed seven persons. The total population capacity of the irrigation system is therefore around 37,800. Of this total 28,000 could be supported by the lands lying within the Teotihuacan Valley (i.e., 4,000 of the 5,400 hectares).

For the alluvial plain of the Middle Valley we have two possible productivity models. If we assume a system of floodwater irrigation comparable to that in vogue today then the average yield would be close to 1200 kgs, including years of total crop loss and considering the variable conditions of canal and dam systems and their use. Under the ideal conditions, characteristic of the hacienda run systems of the late 19th and early twentieth centuries, the average would rise to at least 1400 kgs per hectare. This means that the plain could supply maize for a population of from 18-21,000.

The alluvial plains of the Delta, Lower Valley and Middle Valley would therefore supply maize for a population of 46-49,000 people.

If the model presented by Charlton on page332 as to the nature and character of the Middle Valley alluvial plain in 1519 is correct then the average yield would be similar to or slightly less than that of the adjacent terrace systems. This might reduce the maize producing capacity to as low as 12,000; more probably around 15,000 people or a total of but 40-43,000 for the two plains. For the second class lands; that is, lands lying in sloping areas, but where the supply of flood water terrace irrigation was abundant, it is difficult to make calculations of productivity. Today, much of this area is severely eroded; and its overall demographic potential, therefore is low. In our test study of the Maquixco Strip, we estimate the present-day condition of the land as follows:

Steep uncultivated slope	10%
Gentle Slope, tepetate exposed	20%
Gentle slope, severely eroded	35%
Gentle slope, good agricultural land	25%
Deep soil terraces and presas	10%
	100%

Sixty-five percent of the land in this strip, then, is of marginal value to agriculture today; and this picture is generally true for the total area in question. Within the category of good agricultural land, Charlton estimates an average yield that varies from 1,000 kgs to 1,700 kgs per year. But these calculations do not include years of total or heavy crop losses through droughts or frosts. Even well maintained terrace systems are characterized by a great deal of variation in age, erosion, deposition, and soil depth. Shallow soil terraces, or over-cultivated lands, tend to suffer heavy crop losses in bad years, in some cases, total losses. The average yield, therefore, including these years of heavy losses, over a long period of time, probably does not exceed 1,000 kgs. This would be particularly true during Prehispanic periods with the markedly reduced use of animal fertilizers. If we assume that the functioning part of the Maquixco Alto system was generally characteristic of the total ecological zone during Aztec times, and the Aztec settlement pattern data strongly suggests this, then this niche of the Valley could have supplied maize for a population of perhaps 45,000 people.

For third class lands, those lands that are situated in sloping terrain, and without adequate floodwater irrigation sources, the average yield must have been considerably less. Generally speaking, these lands relied almost exclusively on rainfall for their humidity. The lack of irrigation water would also present much more difficult problems of maintenance of soil fertility, and we suspect that many of these lands either were not utilized for maize, were rotated, or were periodically rested. If all lands were planted in maize and with alternate periods of cultivation and rest or if the lands were rotated between maize and other cultivates like beans, and considering crop losses through frost and droughts, then the average yield of an individual parcel of land in this zone over a long period of time couldn't exceed 600 kgs per hectare. This means that the 8,000 hectares could have supplied maize for only 24,000 people.

One of the problems in evaluating the demographic capacity of the valley is the possible utilization for cultivation of the steeply sloping areas of the Patlachique Range and the string of hills along the north side of the valley. Today this area is badly denuded of soil and cultivation is restricted to small, scattered areas of level topography on or between the hills. Archaeological evidence indicates that during the Formative Period, the area was heavily utilized for agriculture. At the end of the Formative it was apparently abandoned as a major area of agricultural activities, and there is little evidence of its utilization throughout the succeeding Classic and early Postclassic Periods. Aztec sites are few in number and small in size and generally restricted to areas where there is evidence of contemporary cultivation. The implications of this data are that the Patlachique Range suffered heavy erosion during Formative times and was of marginal agricultural value in post-Formative times. It was probably utilized primarily for hunting and gathering during the Aztec period.

In summary, the section of the Teotihuacan Valley included in the survey could have supplied maize for a total population of approximately 109-118,000 people. The capacity of the Upper Valley, an area somewhat smaller in size (approximately 300 km^2) is not known, but the productivity per hectare was certainly considerably far below that of the area considered. The alluvial plains are much smaller (they do not exceed 1,000 hectares) and much shallower with respect to soil depth than the alluvial plains further down valley and are far removed from irrigation water resources. At least 50 percent of the surface of this area can be classified as third-class lands. All is all, it is difficult to see how more than 150-175,000 people could have been supplied with annual maize requirements from the total resources of the Teotihuacan Valley.

All of these calcualtions fail to take into account the amound of land planted in crops other than maize, or the fact that the population of the valley must have produced some surpluses for trade and taxation. With these considerations, Cook and Borah's population estimates become absolutely impossible, and our estimate of 135,000 people for 1519 permits a model in which not all land was in maize and the production of a substantial surplus.

Another factor that would further reduce the population estimate arises from a statement by Juan Pomar , that Nezahualcoyotl, the Texcocan King, diverted some of the water from the Lower Valley irrigation system for land around Texcoco. We have no way of knowing how much water was involved but this diversion would undoubtedly reduce the overall production of the Lower Valley. (See Pomar in Zorita, page 53).

Although our figures are considerably lower than Cook and Borah's, they still indicate a remarkably effective adaptation to the Valley and intensity of land use, with an average density of approximately 200 per km^2.

VI. THE POLITICAL DEMOGRAPHY OF THE BASIN OF MEXICO IN 1519

In this section we will attempt to analyze the political demography of the Basin of Mexico in 1519.

1. Districts and Domains

In 1568 there were 62 cabecera districts in the Basin of Mexico. These districts varied in population from 448 (Acolhuacan) to 52,000 (Mexico City) people. The average population was 6513 and the average size calculates at approximately 120 km^2. As was noted previously the Spaniards converted most of the 1519 states to cabecera districts. A few of the 1568 cabeceras were not former capitals; others were capitals a few decades prior to the Conquest, were conquered by the Aztecs and demoted to a subject status, and then restored to their old rank by the Spaniards. In some cases several rulers had their palaces in the same physical town. In such cases each palace was the center of an attached ward-like division of the town and a discrete rural domain. The Spaniards converted the separate domains into one and demoted the less powerful rulers to tributaries, considering the physical town as a single cabecera. Changes were also made in the specific territorial limits and alignments of subject villages of the former states so that the 1568 cabecera districts did not correspond exactly. It would be virtually impossible, therefore, to make specific estimates of the population and territorial size of each domain in 1519. In the following summary we will attempt to provide estimates of average population size, based on our projected curves of decline.

The twentieth century judicial district of Chalco corresponds roughly to the old province. Included in the twentieth century district but not in the sixteenth century province were the cabeceras of Coatepec and Ixtapaluca. The population in 1568, including those two districts was 40,400 according to Cook and Borah. We have corrected this figure upward to 61,600-64,400. For 1519 our calculated estimate is between 166,320-193,200 (in both estimates we have excluded Coatepec and Ixtapaluca). In 1519 there were 10 domains in the province of Chalco. Of the ten, five were centered at the single town of Amecameca, three at Tlalmanalco, one at Tepetlixpa Chimalhuacan (the Chimalhuacan-Chalco of the 1560's) and another at Tenango Tepolula.

The average population of the domains was between 13,860-16,100 persons. If we make the assumption that few territorial changes were made by the Spaniards then the bulk of the population, perhaps 50%,were subject to the three rulers of Tlalmanalco, perhaps 80-100,000 people. The bulk of the lakeshore plain, one of the most extensive in the Basin of Mexico, and the eastern chinampas were owned by Tlalmanalco so that this population is hardly surprising. The balance of the province was composed of gently sloping piedmont and steep hillsides.

The situation in the twentieth century delegacion of Xochimilco was much less complex. Most of the delegacion equated with the old province of Xochimilco. The entire province was controlled by three rulers, all with their palaces located at the single physical town of Xochimilco. Not included in the old province, but included within the twentieth century delegacion were Cuitlahuac, the capital of four rulers in 1519 and Mixquic the capital of one. In the eight domains there was a total of 100,623-111,804 people in 1519 with an average population of 12,578-13,976. In the case of this area, there was apparently little shift in territorial boundaries after the Conquest so that one can make some estimates of internal population distribution. The three domains of Xochimilco, (those included in the 1568 cabecera districts of Xochimilco and Milpa Alta) applying our formula, had a total population of between 83,749-93,054 in 1519 or an average of 27,916-31,018 for each. The four rulers of Cuitlahuac shared a population of 10,495-11,661 or

an average of only 2,624-2,915 per ruler. The single ruler of Mixquic was served by a population of 6,380-7,089 in 1519.

The two twentieth century districts of Otumba and Texcoco corresponded very closely to that portion of the old province of Acolhuacan that was located within the Basin of Mexico. In 1568 this area had 101,406 people. Our 1519 calcualtion is between 273,796-304,218. The history of the territorial limits and number of administrative units for this province between 1450-1568 is exceedingly complex, as the product of Texcoco's manipulation of conquered states prior to the Spanish Conquest and political machinations after it. At the time of the Conquest there were rulers in twelve towns; Texcoco, Chimalhuacan, Coatlichan, Huexotla, Chiautla, Tepetlaoxtoc, Tezoyuca, Tepexpan, Chiconauhtla, Acolman, Otumba and Teotihuacan. A number of other towns had rulers in the mid-fifteenth century but had been converted by Nezahualcoyotl to direct tributary status. If we take the existing rulers in 1519 then the average domain included a population varying from 22,816-25,352.

Any attempt to relate the population figures to specific domains is frought with particular difficulties with respect to this area. First, Texcoco succeeded in reducing three former capitals, Chiautla, Coatlichan, and Tezoyuca to direct subject status so that Cook and Borah's 1568 population figure for Texcoco refers to this extended domain. The only source we have been able to locate that sorts out the four cabeceras is the Franciscan Codex, an ecclesiastic document. Bearing in mind that the ecclesiastic districts did not always coincide with tax districts and that one cannot be sure that either coincided exactly with the states of 1519, we would suggest a distribution of population in 1519 as follows: for Texcoco 43,200-51,000, Chiautla 6,750-7,500, Coatlichan 13,500-15,000, and Tezoyuca 4,050-4,500. To obtain a total figure for the Texcoco 1519 domain we must also add the population of ten other states that had been demoted, some of which were reconverted to district status by the Spaniards. The changes in Postconquest times, of these territories would make it exceedingly difficult to sort them out so we will simply offer here a reasonable estimate that the ruler of Texcoco must have had a direct tributary population of approximately 100,000 people in 1519.

Those portions of Acolhuacan that lay within the Teotihuacan Valley have been discussed in the previous section. Our data would suggest a range in population of the 1519 domains of between 4,000 for Chiconauhtla to a maximum of 30,000 for Otumba (the figure for Otumba excludes Oxtotipac, Cuautlancingo, and Axapusco which were direct tributaries of Texcoco).

Moving to the west central (i.e., the area west of Lake Texcoco) portion of the Basin of Mexico, the reconstruction of the political demography in 1519 is an even more difficult problem. Although the Spaniards emphasized the great size of the dual city of Tenochtitlan-Tlatelolco in 1519 they also noted the presence of a number of large towns and numerous smaller settlements on the adjacent lakeshore plain and piedmont. With the exception of Tacuba and Coyoacan which evolved into large suburbs of the Colonial city after the Conquest, many of these towns had declined to the demographic status of small villages by 1568. We have previously suggested that this was the product of immigration to the city. As a consequence, the relative population distribution of the cabecera districts in 1568 did not correspond at all to the domains in 1519. The population movement was probably local and internal, however, with respect to the district and one can therefore apply the formula to the 1568 population of the entire district to obtain a total population for 1519. This calculates between 354,256-393,618. Of this perhaps between 120,000-200,000 pertained to the joint cities of Tenochtitlan-Tlatelolco and their dependent chinampa and mainland villages. The balance was distributed among ten domains or an average of 19,362-23,426 people.

For the northwestern part of the basin (the districts of Cuauhtitlan, Zumpango) Gibson notes that capitals were located at Toltitlan, Tepozotlan, Hueypoxtla, Tequixquiac and Xilotzingo and that the former centers of Zumpango, Citlaltepec and Huehuetoca and had been reduced to direct subject status to Cuauhtitlan prior to the Spanish Conquest. The Spaniards restored them to cabecera status after the Conquest. Two other Postconquest cabeceras within the area, Xaltocan and Tizayuca had been reduced to direct subject status to Texcoco. Not included in Gibson's study were the colonial cabeceras of Apaxco and Teotlalpa so we have excluded them. The total population of the two districts of Cuauhtitlan and Zumpango was 61,142 in 1568. Applying our formula the population was between 165,083-183,426 in 1519. This population was subject to six rulers or an average of 27,514-30,571. In fact approximately 70,000-75,000 were tributary to the ruler of Cuauhtitlan and the remaining five shared 95,000-110,000 tributaries or an average of 19,000-22,000 each.

Summarizing, in 1519, there was considerable variation in the size of the domains from a few thousand up to Tenochtitlan's possible 200,000. Although we cannot present a dependable grouping of these districts by population size, the mode would undoubtedly fall between ten and thirty thousand. A few domains far exceeded this size, Tenochtitlan, Texcoco,Cuauhtitlan, probably Tacuba (Tlacopan), and if we combine those domains that had their centers in the same town, Xochimilco and Tlalmanalco.

These demographic characteristics apply pretty well to the balance of the Central Mexican Symbiotic region. Within the rest of the area were several unusually large states (if we group those which shared the same cabecera) such as Cholula, Tlaxcala, Huejotzingo, and probably Quanahuac. The range and mode of the smaller domains was comparable to those in the Basin of Mexico.

2. Community Size

In our previous comparisons of the 1568 and 1519 population we emphasized the point that the smaller the territorial unit, the more difficult it is to allow for local population movement and realignments of communities due to changes in territorial borders. It is primarily for this reason we selected the 20th C. judicial districts as our unit of comparison. In our attempt to provide some impression of the population size of the Preconquest states we worked with averages rather than attempting to apply our population decline ratios to individual cabecera districts since we could not be absolutely sure that the old domains corresponded exactly to the Postconquest districts.

Ideally we would like to be able to calculate the population size not only for each state but for each of the central towns and all of the individual independent settlements, but there are a number of problems that make this a virtually impossible objective. We do know that in most domains only a fraction of the population lived at the central town. The percentage that lived in the center varied considerably, due only in part to the size of the dependent population. From the inception of their administrative system the Spanish state and church carried out extensive programs of relocation and centralization of population, so that numerous small settlements were abandoned. Although the civil "congregacion", as this policy was called, was not applied on a grand scale until after 1600 in the Teotihuacan Valley it is quite obvious from a comparison of our Aztec settlement data with the 1580 map that numerous small settlements were abandoned prior to

that time, in part the product of relocation by the church, and in part the product of less formal processes of local movement from marginal locations. As a result, there definitely was a total decline of population of the individual domains but we are not able to assess its relationship to the population history of individual communities. In our future monograph on settlement patterns, we will apply the Aztec period archaeological data to the problem and attempt to establish ranges, modes and averages of population for the rural settlements in the valley.

For the Teotihuacan Valley we can make a rough estimate of the probable percentage of the population residing in the cabeceras of four of the states (Chiconauhtla, Acolman, Tepexpan and Otumba), based on a comparison of estimates from archaeological data on the population of the cabeceras (see Sanders 1965) and from documentary data on the population of the domain. The data is presented in the table below:

Domain	Population of the Cabecera (Archaeological Data)	1568 Pop. Documentary Data (Total Domain)	1519 Pop. (Calculated from 1568 Figures) (Total Domain)
Tepexpan	900-1,200	4,421	11,937-13,263
Chiconauhtla	2,500-5,000	1,478	3,991- 4,434
Acolman	3,600-4,800	11,480	30,996-34,440
Otumba	3,200-6,400	12,000	33,600-36,000
TOTAL	10,200-17,400		80,524-88,137

Chiconauhtla on the basis of both documentary and archaeological data was a completely nucleated domain and our independently derived estimate from the two sources of data conforms strikingly. With respect to the other three, between 12-22 percent of the population resided in the central community.

Spanish statements indicate that most of the cabeceras in 1519 in the Basin of Mexico were comparable either in political rank or population size to our four test cases from the Teotihuacan Valley. This would suggest that the smaller cabeceras in the Basin ranged in population from 1-7000 in 1519. In this category would be certainly included the following cabeceras: Chimalhuacan-Chalco, Tepetlixpa Chimalhuacan, Tenango Tepolula, Chimalhuacan, Chiautla, Tepetlaoztoc, Tezoyuca, Tepozotlan, Tultitlan, Ecatepec, Tenayuca, Hueypostla, Jilotzingo, Tequixquiac, Tlapanaloya and Coyoacan. At the opposite end would be Tenochtitlan with our estimated minimum of 82,000 (see below). The others fall between these figures but overwhelmingly at the lower end of the range. There are a number of problems. Cuauhtitlan possibly was somewhat larger than the group of small centers but there is no good evidence that it was and we suspect Culhuacan, Azcaputzalco and Tlacopan were larger also. Torquemada classifies them on the same level as Otumba however so there is a possibility that they were within the range. Huexotla and Coatlichan, on the basis of documentary data, would be relegated to the status of this lower group but recent settlement pattern surveys made by Parsons would suggest that much of the population of these domains was nucleated. If so, it would put the cabeceras in the 10-20 thousand bracket. Other cabeceras of relatively small states were probably in this size bracket as well since they were cases where most of the population was nucleated in the central town. Examples of these are Cuitlahuac, Mixquic, Ixtapalapa, Mexicalcingo and Huitzilopochco, all chinampa communities.

There is another problem, however, in connection with the chinampa settlements. Recent archaeological survey by Armillas indicates that most of the chinampa farmers resided on their holdings so that most of the population resided outside of the cabecera proper in what amounts to a rancheria settlement pattern. Because of the high level of productivity of chinampa farming the density of rural settlement was unusually high (perhaps as high as 1000 per Km^2 in some areas) and a chinampa domain would appear as a single physical community from the air. In fact, since the domain borders merged, the entire chinampa area might appear as one huge settlement.

Other centers such as Texcoco, Amecameca, Xochimilco and Tlalmanalco certainly exceeded 10,000 inhabitants. We have estimated the probable 1519 population of the core domain of Texcoco at 43,200-51,000. How much of the population resided at the center is not known. In a recent archaeological survey Parsons estimated a population of 20,000 or somewhat less than half of the total. In terms of the areal extent of the site it certainly could not have exceeded a population of 30,000. Both of these figures are cited as the population of the city in 1519 by the 16th Century writers but in terms of vecinos or casas rather than total population.

3. The Special Problem of Tenochtitlan

The population of Tenochtitlan at the moment of the Spanish Conquest has stimulated considerable controversy over the years. Documentary sources provide us with three estimates; one 60,000 casas, a figure derived ultimately from Cortez and repeated by various later writers, is the most common base from which modern writers have calculated population. One source, the Anonymous Conqueror (probably Andres Tapia) cites 60000 people but the only version of his work is an Italian version and it is possible that the Italian translator misinterpreted the Spanish word vecino. Torquemada, with his usual zeal cites a figure of 120,000 casas and then adds that each casa contained 1, 3, 4 and even 10 vecinos or householders. Most contemporary writers have multiplied Cortez's figure of 60,000 casas by a factor of 5 to obtain a total population of 300,000. Even if Torquemada exaggerated somewhat the number of families per house and we use the average of 7 persons derived from the Suma as the size of an average household, the estimate of 60,000 casas would yield a population of 420,000. In fact the urban character of the center with its large upper and middle class would seem to demand a higher average number. In Tepoztlan, a small cabecera, Carrasco (1964) reports the household of the cacique as comprising 23 persons.

None of these figures, even the lowest one of 300,000 we feel are acceptable. The maximum size of the city certainly did not exceed 12 Km^2 and it may have been as low as 8. A population of 300,000 would yield a density of between 25,000-37,500 per Km^2 which is much too high for a community of single storied houses and one furthermore that included chinampas, and a great number of plazas and public buildings. Even the most congested villages and towns in the Basin of Mexico today do not have densities exceeding 10-12,000 persons per Km^2.

Although we have only a very incomplete picture of the plan of Aztec Tenochtitlan it cannot have differed strikingly in overall plan from the Postconquest Colonial city and fortunately we have a series of maps of the city that provide a fairly clear and consistent picture.

In the mid 16th Century the city covered approximately 8 km2 (including Tlatelolco); the tributary Indian population was approximately 67,000. The mid 16th Century city consisted of a core that formed a square measuring 1.5 x 1.5 km or a surface area of 2.25 km2. This core was occupied primarily by the Spanish immigrants, mestizos and Negro slaves and included the civic center, (located in the same area as the Aztec center), public buildings and a grid of streets along which were aligned houses in a pattern comparable to the more urbanized Mexican towns today. The area in 1570 had a population of approximately 12,500 (PNE, Tomo III). Around this core was a zone that covered approximately 5.75 km2, crisscrossed by a rectangular grid of canals and streets. The area was occupied primarily by Indians and the old civic center of Tlatelolco on the northwestern edge of the city apparently functioned as an Indian civic, social and commercial center. The Indian population was organized into 50-60 barrios. The famous Maguey Map apparently is a 16th Century map of a portion of the Indian section of the city. It shows a perfect grid of land holdings, each in the form of a square divided up into a series of tiny rectangles, the latter representing chinampas. Each square contains a house. A total of 400 houses are indicated in the map. If we calculate an average of 7 persons per house then the map shows a residential area with a population of approximately 2,800 persons. A major problem is the identification of the specific area of the Colonial city that the map pertains to. Toussaint, Hernandez, and Orozco (1938) have identified it as an area in the northeast sector, based on the identification of a church indicated on the map as Santa Maria. In fact there were two Santa Maria barrio churches in the 16th Century Mexico City, one located in the northeast, the other in the northwest section of the city. The pattern of canals indicated on the map in reality corresponds much more closely with the barrio of Santa Maria La Redonda in the northwest sector. If we place it in that area then the surface area of the Maguey Map is approximately 21.3 hectares with an average size per family holding of 530 M2. Toussaint et. al. based, on their identification of the map as pertaining to an area in the northeastern portion of the city, estimated the average holding as 575 M2. The density in the first case calculates at 13,145 per km2 in the second at 12,100. If we multiply these densities by the total area occupied by the Indians then the Indian population calculates at approximately 70,000, a figure slightly higher than that of the 67,000 Indians for the 16th Century censuses. The explanation is probably that the Maguey Map covers a somewhat larger area than indicated by our or Toussaint's study and our two estimates are obviously rough approximations. In any case the chinampa holdings were extremely small and even considering the extraordinary productivity of chinampa agriculture could only have supplied a small percentage of the income of the Indian family.

For example, assuming that the Indians in Mexico City were entirely agricultural in way of life, produced all their basic foodstuffs along with a surplus of 50% for trade. The maximum population density supportable by chinampa agriculture would be 1000 per km2. If they had a fully commercial crop economy comparable to some contemporary chinamperos the maximum density ascends to 2000 per km2. If the chinampas were all planted in subsistence crops and produced no surplus for trade items the maximum density would be approximately 1500 per km2. All of these figures are far below the actual population density of the chinampa area of the Maguey Map. The clue is provided by a statement in the source, Arzobispado de Mexico Hecha en 1570, to the effect that the Indian population of the city grew some food but supported themselves primarily from craft and commercial activities.

Much of the Prehispanic Tenochtitlan was probably similar in ecological zoning to the mid 16th Century city. The two civic precincts and elite residential areas of Tenochtitlan and Tlatelolco were equivalent in ecological function and probably in area and population density to the Colonial Spanish portion of the city. If we round off this area to 2 Km^2 the population would have been in the neighborhood of 10,000. Presumably this population included full-time specialists in religion, government and economics. The balance of the population were probably distributed in a chinampa grid system comparable in density to that of the Maguey Map and included part-time farmers and craftsmen. This portion of the city covered minimally 6 Km^2. If we estimate an average density of 12,000 per hectare then the population calculates at 72,000 or 82,000 in all. Beyond this densely clustered ring of chinampas was a wide band of unknown density and size of chinampas probably inhabited by full-time farmers. The density was probably comparable to that found by Armillas in his study of Aztec chinampas around Xochimilco in which each chinampero held an average of 0.4 hectare of land. Whether the population in this zone should be considered inhabitants of the city is a question of definition. Ecologically their mode of life can be called rural, yet even from this point of view the agriculture practiced was probably focused on commercial crops for the urban market and the degree of involvement with urban life and economy was clearly much greater than in normal peasant communities. Politically and socially the area was undoubtedly considered by the Aztecs themselves as a part of the twin cities. We have previously estimated a total population of between 120-200,000 directly tributary to the ruler of Tenochtitlan. This figure includes the 82,000 of the core city, so between 40,000-120,000 people resided in the fringe chinampas and mainland villages and hamlets that made up the balance of the domain.

Our picture of the economic structure and settlement pattern of the city and its immediate rural hinterland parallels, on a much larger scale of course the characteristics of small Aztec towns in the Teotihuacan Valley.

Aside from the residential complex that equates with the core state of Tenochtitlan-Tlatelolco the adjacent lake and lakeshore was crowded with substantial towns and numerous villages, the former connected by causeways to the capital. This, plus the densely settled chinampas areas would, in 1519, have given the appearance of a single huge settlement complex of varying density, the most massive concentration of settlement in the history of Mesoamerica.

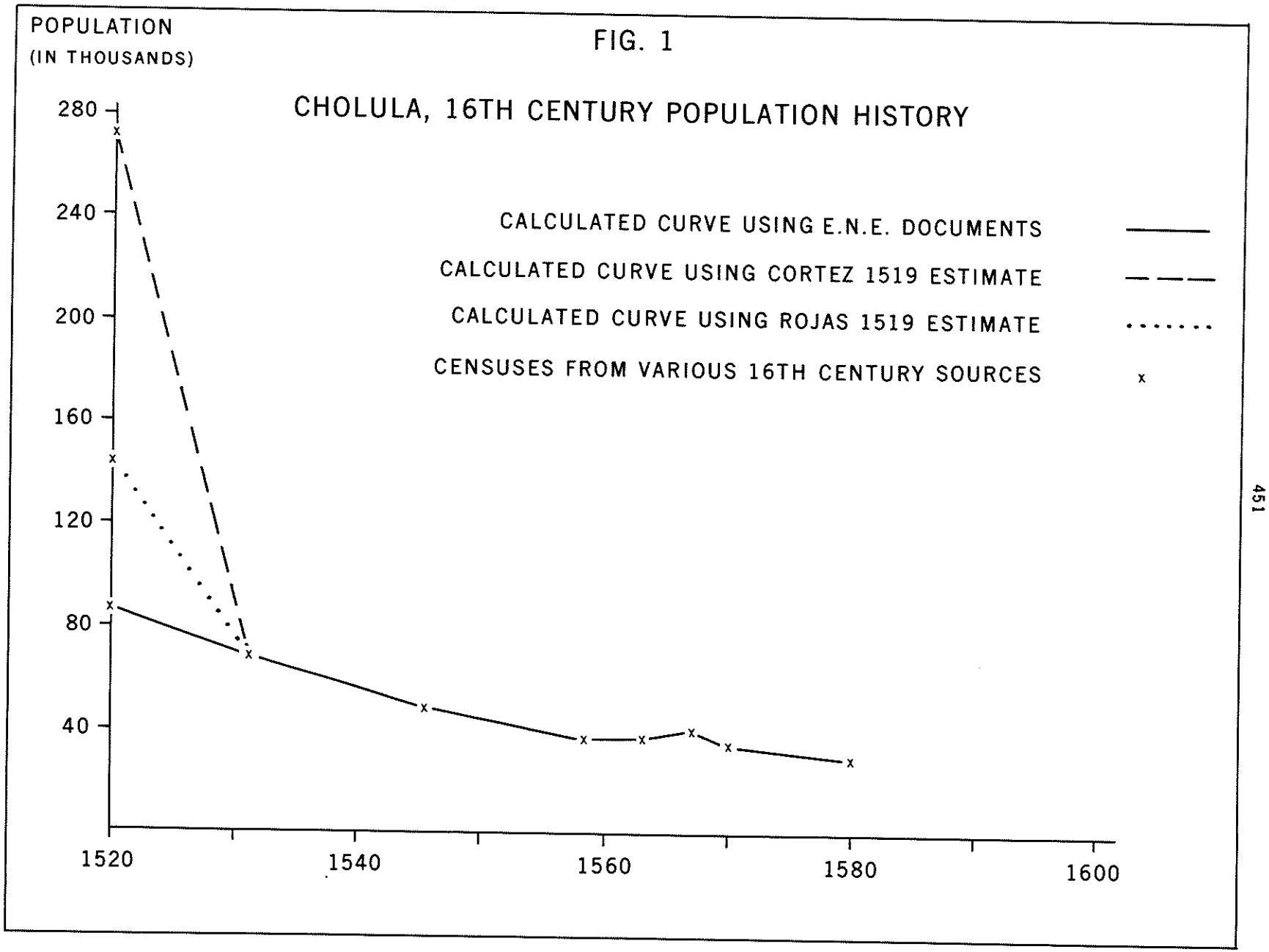
4. The Urban-Rural Ratio.

In a previous section we estimated the population of the Basin of Mexico in 1519 at between 1,000,000-1,200,000 inhabitants. It would be useful to be able to estimate the ratio of urban to rural population or phrasing it more correctly the ratio between cabecera populations and that of dependent settlements. We make this point because some of the population of the cabeceras were probably full-time farmers and it is debatable as to whether these should be classified as urban simply because of residence in the cabeceras. This would be particularly true of the smaller cabeceras where the majority of the population may well have been farmers. Our estimates of cabecera populations are summarized below:

Tenochtitlan-Tlatelolco	80,000
Texcoco	20 -30,000
Five Third Level Cabeceras, average population 15,000 *	75,000
40 Fourth Level Cabeceras, average population 4-5,000	160-200,000
	355-385,000

*Xochimilco, Amecameca, Tlalmanalco, Tlacopan (Tacuba), Ixtapalapa

According to these calculations approximately 1/3 of the population of the Basin of Mexico resided in towns and cities in 1519.


POPULATION
(IN THOUSANDS)
FIG. 1
CHOLULA, 16TH CENTURY POPULATION HISTORY
280
240
200
160
120
80
40
1520
1540
1560
1580
1600
CALCULATED CURVE USING E.N.E. DOCUMENTS
CALCULATED CURVE USING CORTEZ 1519 ESTIMATE
CALCULATED CURVE USING ROJAS 1519 ESTIMATE
CENSUSES FROM VARIOUS 16TH CENTURY SOURCES

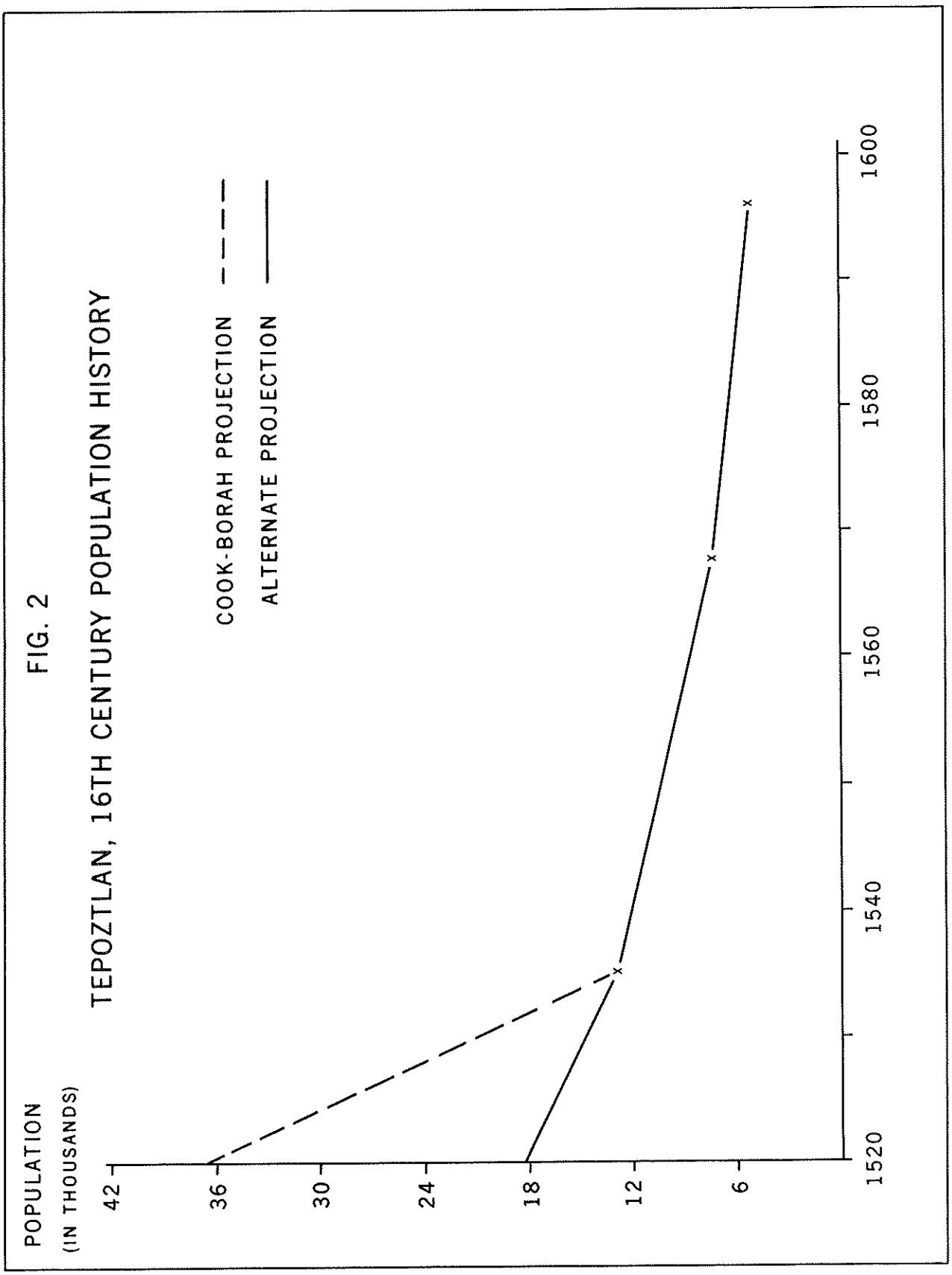


FIG. 2
TEPOZTLAN, 16TH CENTURY POPULATION HISTORY
POPULATION
(IN THOUSANDS)
42
36
30
24
18
12
6
1520
1540
1560
1580
1600
COOK-BORAH PROJECTION
ALTERNATE PROJECTION

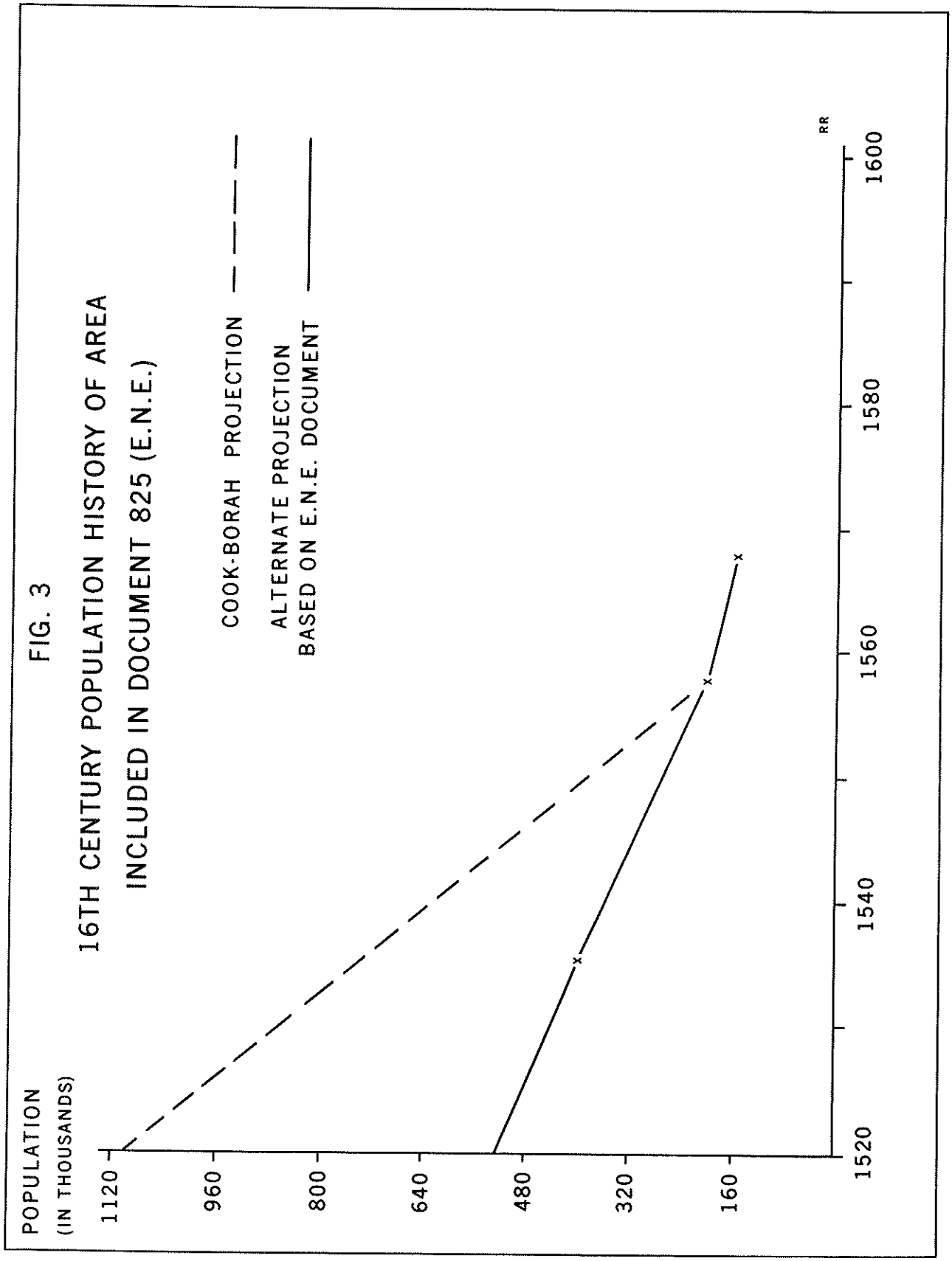


FIG. 3
16TH CENTURY POPULATION HISTORY OF AREA
INCLUDED IN DOCUMENT 825 (E.N.E.)
COOK-BORAH PROJECTION
ALTERNATE PROJECTION
BASED ON E.N.E. DOCUMENT
POPULATION
(IN THOUSANDS)
1120
960
800
640
480
320
160
1520
1540
1560
1580
1600
RR

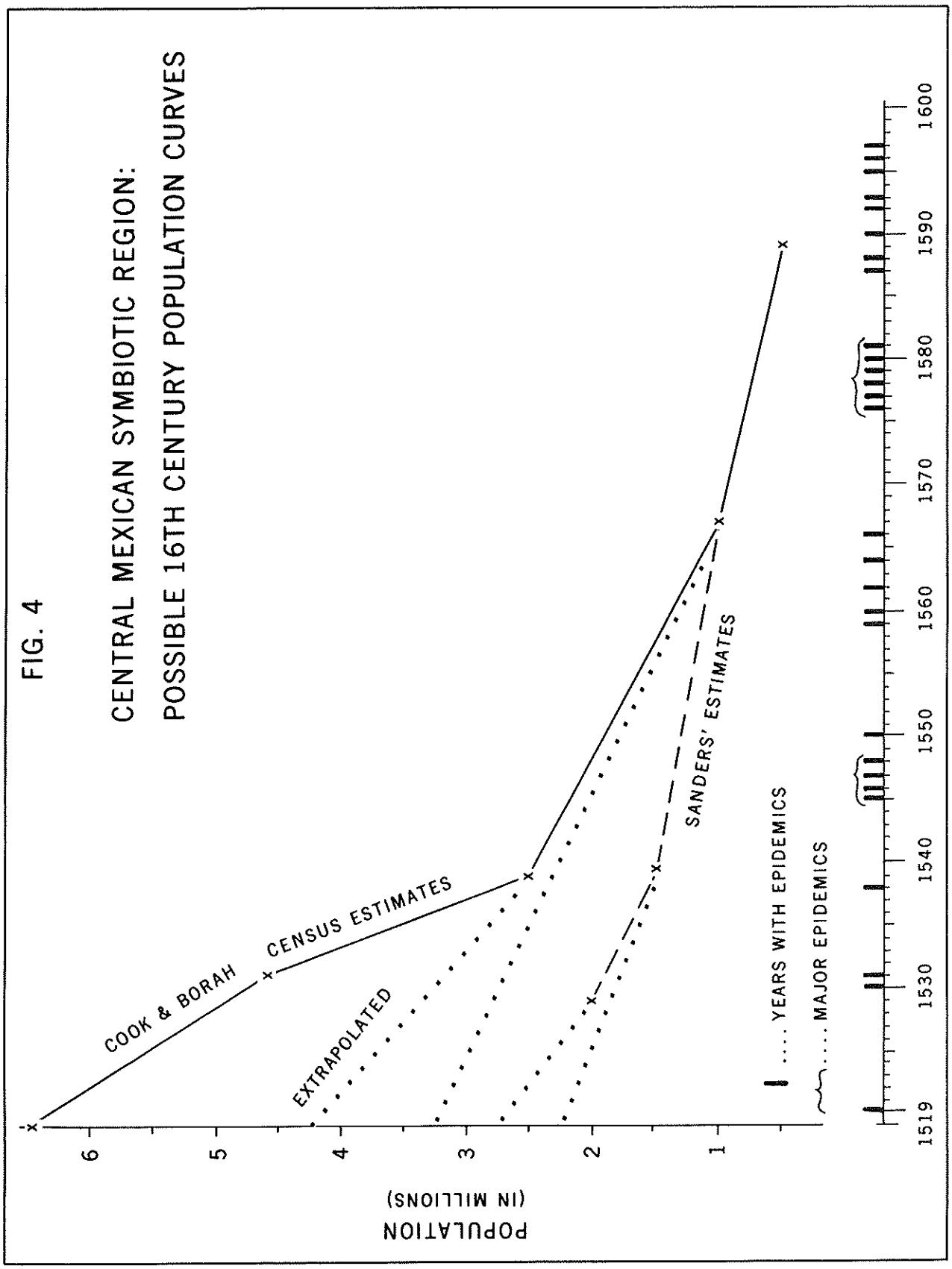


FIG. 4
CENTRAL MEXICAN SYMBIOTIC REGION:
POSSIBLE 16TH CENTURY POPULATION CURVES
POPULATION
(IN MILLIONS)
6
5
4
3
2
1
COOK & BORAH
CENSUS ESTIMATES
EXTRAPOLATED
SANDERS' ESTIMATES
..... YEARS WITH EPIDEMICS
..... MAJOR EPIDEMICS
1519
1530
1540
1550
1560
1570
1580
1590
1600

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