

## Gardens on Swamps

Archeological research verifies historical data on Aztec land reclamation in the Valley of Mexico.

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A system of shallow lacustrine basins forms the floor of the mountain-girt plateau known as the Valley of Mexico. This was the heartland of the Aztec empire. At the time of the Spanish conquest in 1521, the Aztec capital city Tenochtitlan stood on an island in an embayment of Lake Tezcoco (Fig. 1). To the south, and screened by a range of volcanic cones, extends a subdivision of the valley, the Xochimilco-Chalco Basin. The bottom of this basin encompasses about 200 square kilometers of flats. Until 70 years ago, when the completion of drainage works caused the desiccation of most of the area, a continuous tract of marshes, swamps, and lagoons extended on these bottoms from the eastern head of the basin to the natural outlet that led into Lake Tezcoco through the narrows situated between Culhuacan and Huitzilopochco. Since pre-Columbian times, garden plots raised above water have been built on these swamps. My recent investigation, based on the interpretation of aerial photographs and the inspection on the ground of traces of the old field system, has revealed that the extent of the raised plots in the Xochimilco-Chalco Basin was much greater in the Aztec period than had been recognized (Fig. 2). Also, archeological evidence has been obtained to substantiate the descriptions left by 16th-century

witnesses of native land-reclamation methods. The results of the research on this ancient farming system are important in retrospective studies of demography and political economy; their broader significance can be seen in terms of cultural ecology.

### The Chinampas

The natives' methods of expanding farmland over swamps and lagoons in the Valley of Mexico were described by a number of early Spanish Colonial writers from the 16th century onward. In freshwater lagoons, wrote one of them, the Indians "without much trouble plant and harvest their maize and greens, for all over are ridges called chinampas; these are strips built above water and surrounded by ditches, which obviates watering" (1). Late in the 16th century, after the disruption caused by the razing of Tenochtitlan and the changes in hydrography due to clumsy attempts at flood control, these garden plots were still farmed by Indians in the outlying wards of Mexico City, the Spanish town rebuilt over the rubble of the destroyed Aztec capital. Within the same embayment of Lake Tezcoco, other areas of chinampas extended around island settlements, such as Izta-calco, and off the shore of the mainland, at Huitzilopochco and Iztapalapa. But at that time, as has been true since before the Spanish conquest, the

Xochimilco-Chalco district was unquestionably acknowledged to be the core area of chinampa horticulture.

The pattern and procedure for the laying of these plots, and the essentials of the farming system, are outlined in the following excerpts from 16th-century reports: "they make garden plots . . . carrying in canoes sod cut in the mainland, to heap it up in shallow waters, thus forming ridges from 3 to 4 varas wide [about 2.52 to 3.36 meters] and raised half a vara above the water; a farm has many of these ridges, and the farmers circulate in their canoes between them, to tend the crops" (2); "these plots are . . . built upon the water by heaping sod from land and mud from the lagoon, forming very narrow strips . . . separated by canals and, as these gardens are raised less than a vara above the water, even without rainfall they bear vigorous maize, sustained by the moisture provided by the lagoon"; and, "they set maize seedbeds on the chinampas and they transplant the seedlings, which is a thing peculiar to that country" (3). Seedlings were also started on floating foundations, according to another witness. These movable nurseries were "20 to 30 feet long [about 6 to 9 meters] and as broad as the farmer deems convenient, laid on rush, cattail, and sward; on these they set seedbeds for vegetables which are to be transplanted later, and they tow them with ropes from one place to another within the lagoon" (4). Parenthetically, the legend of the so-called Montezuma's floating gardens (which induced the figment that Aztec horticulture was waterborne and that latter-day chinampas were grounded derelicts) appears to have arisen through errors of observation made by some witnesses who mistook the movable nurseries for the farm plots.

As these reports make clear, the layout of the chinampas was designed to capture moisture. Standing water is essential for the operation of the system. In these artificial islets, the porosity of the soil and the narrowness of the strips allows seepage from the surrounding

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canals to keep the soil perpetually moist where it counts most, at root level. Permanent irrigation by seepage permits continuous cultivation on the plots, even through the dry season of the year (Fig. 3).

The practice of planting in seedbeds saves space, since the seedlings can be planted in a little corner of the plot, or in the farmer's backyard, or on the rafts used in earlier times; it also improves crop yield, since only healthy sprigs are transplanted. The seeding is timed so that the shoots are ready for transplanting immediately after the previous crop has been harvested. Thus the fertile soil is kept in an intensive cycle of production.

To keep the plots under continuous cultivation, the ancient chinampa farm-

ers sustained the fertility of the soil by mucking and manuring, as their descendants still do today. The words for farming practices listed in the 16th-century dictionaries of the native (Nahuatl) language, as well as references by contemporary witnesses, indicate that mucking (scooping from the surrounding canals mud rich in organic nutrients and spreading it over the chinampa) and manuring (with a compost that included aquatic weeds and, probably, night soil too) were common practices in Aztec times (5).

Plot building on swamps, permanent irrigation, the use of fertilizers produced by the ecosystem, and planting in seedbeds (to intensify the cycle of production) were enmeshed in the system of chinampa horticulture.

### Theoretical Underpinnings

The investigation of pre-Columbian undertakings in swamp reclamation in the Xochimilco-Chalco Basin was conceived as an integral part of a more comprehensive research project: the study of man's role in shaping the landscape in the Valley of Mexico through the 2000 years preceding the Spanish conquest (roughly, 500 B.C. to A.D. 1500). This study can shed light on the relations between the growth of civilization and the development of resources (and vice versa) in the region that became the hearth of the Aztec empire.

My project was designed within the conceptual framework of landscape archeology, which is a relatively new discipline pioneered by British archeologists. The study of ancient cultural landscapes involves the investigation of all man-made features related to what geographers call the organization of space. The basic tenet of landscape archeology is that, through the integration of the data on the features of land use that characterized a man-shaped habitat (including settlement, field systems, and hydraulic works, as well as the layout of the web of trackways, causeways, and waterways that linked the components of the regional system), one can perceive the cultural landscape as a reflection of the interplay between the environment and the technology, structure, and values of the society that shaped it.

Such a study transcends the limitations imposed by the traditional approach to "sites" as discrete units; these units are often conceptualized as the largest definable entities fit for archeological research. Also, although their subject matter overlaps, landscape archeology and studies of settlement patterns differ in scope, the former being the broader, the latter often being limited (although not by the best practitioners of the art) to analysis of internal structure, functional differentiation, and size and spatial distribution of towns and villages. The twist that gives meaning to the term landscape archeology is the emphasis it places on the study of civilization's imprint on the countryside—the modifications of the natural environment through man's constructive and exploitative activities. Finally, in contrast to environmental archeology, which tends to focus upon the natural aspects of the habitat, the emphasis of landscape archeology is on man's works

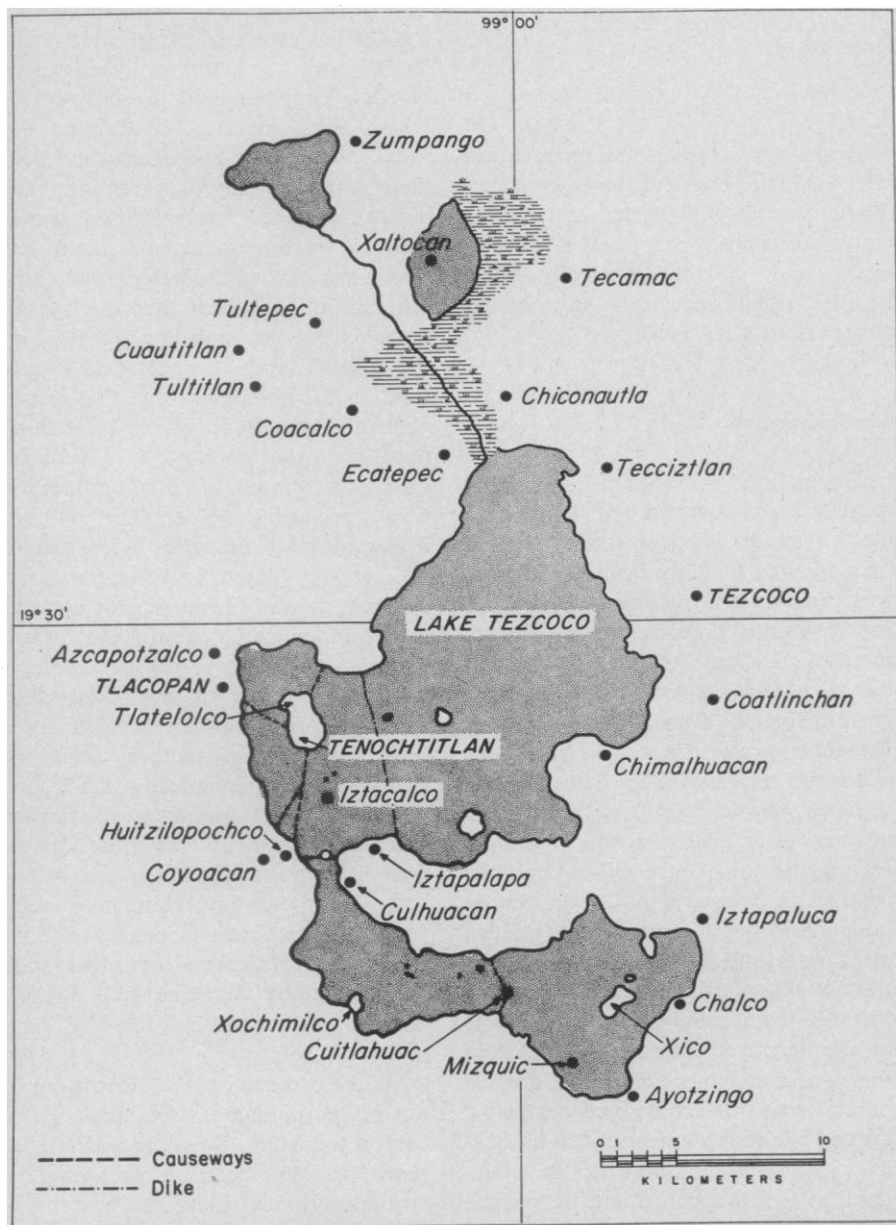


Fig. 1. Lake areas and main towns in the Valley of Mexico around A.D. 1500.

to reshape the physical environment in terms of his cultural desiderata. Nevertheless, it is obvious that the two sub-disciplines are complementary and that the features distinguishing them depend on their different perspectives on a common subject—the study of the interrelationships between culture and environment.

Because of unending reshaping, the landscape in areas of old civilizations can be pictured as a sort of palimpsest on which the marks of man's efforts to change the natural environment are continually being erased and rewritten, and quite often smudged (6). It is the task of the landscape archeologist to map these marks, to date the features, and to discern the functional and historical relationships among them. The goal of these endeavors is to attain a comprehensive view of the man-made environment of a particular period and to trace the evolution of the landscape—its genesis and its fading away as a result of mismanagement, the impact of new technologies, or changing cultural demands upon the environment.

### Aerial Views, Old Maps, and Footwork

Methodologically, the archeological investigation of a cultural landscape begins with the interpretation of aerial photographs. The view from the air reveals the faded outlines of many features of the old landscapes—marks that are often hardly perceptible at ground level. Also, by virtue of its synoptic character, the aerial map discloses the relations among the component parts of the intricate patchwork that constitutes the living landscape, and it affords clues for interpreting these features in terms of their historical development. I started by scrutinizing a large number of aerial maps and sets of stereographs produced commercially by the *Compañía Mexicana de Aerofoto*. The earliest of these pictures were taken in the late 1930's. They are now historical documents of exceptional importance because, since the late 1950's, the obliteration of vestiges of the ancient cultural landscape has been rapidly accelerated by construction and deep plowing. However, traces of the old chinampa system are shown in rich

detail in more recent aerial photos of the less disturbed sections.

A mosaic at the scale of 1:25,000 provides an overview of the whole Xochimilco-Chalco Basin. One can trace on this picture the old shorelines and the cobweb of through-traffic waterways that formed the arterial system of regional transportation. It was used as the base map on which were plotted details of the ancient pattern of land use taken from larger-scale pictures. Also, most of the area included in my survey is covered by sectional photographs at the scale of 1:10,000. This scale proved adequate not only for identifying the marks of the grid of feeder canals that crisscrossed the zones of chinampas and divided them into blocks of parallel plot-and-ditch sets, but even for counting ridges on each block. In addition, the advantage of photographs taken at a low altitude was tested on a 4-square-kilometer area northeast of Xochimilco (the area was chosen after having been explored on foot and photographed for my project by *Compañía Mexicana de Aerofoto*). On these photographs, the outlines

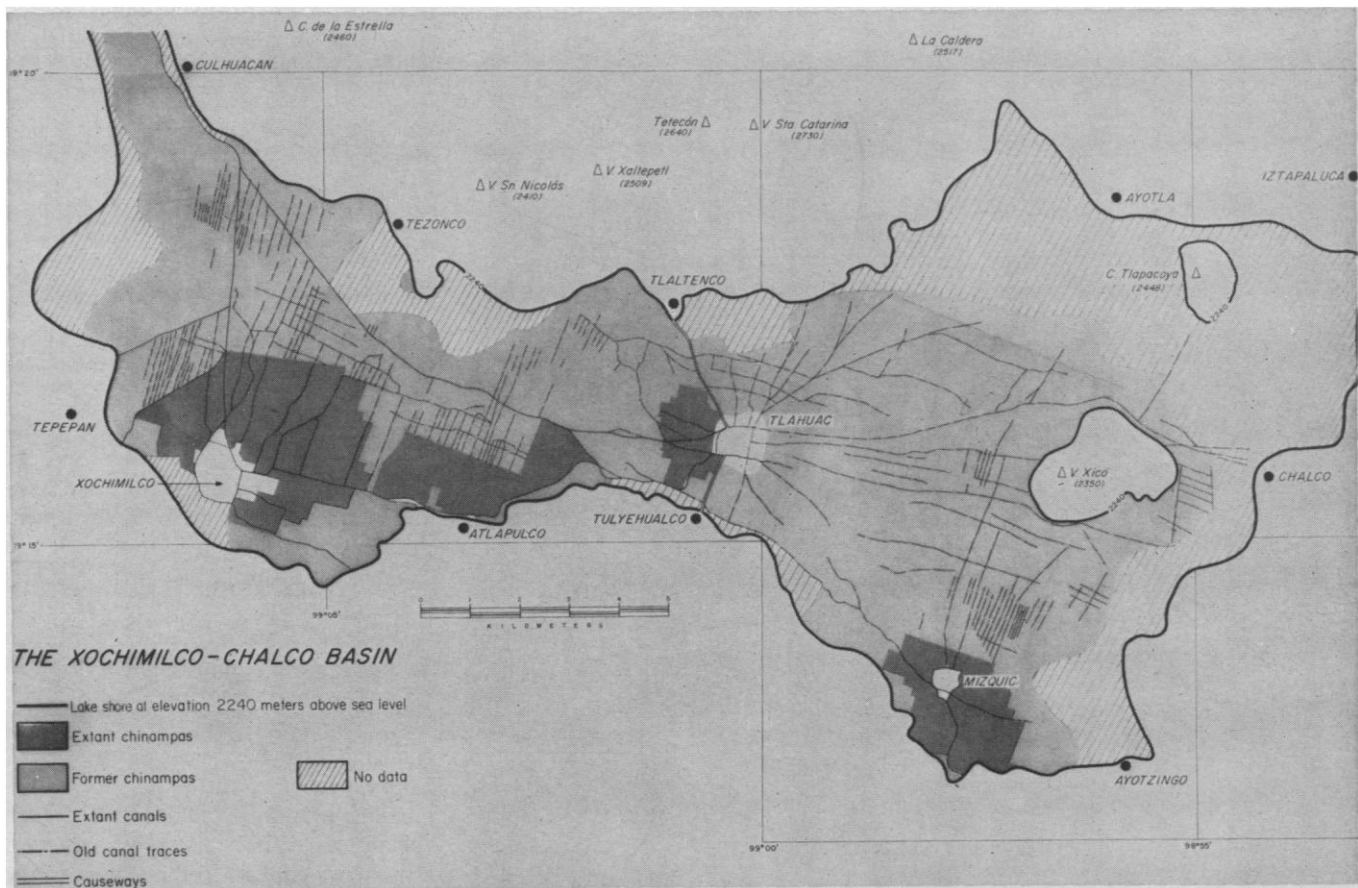


Fig. 2. Map of the Xochimilco-Chalco lacustrine basin, showing the extent of ancient swamp reclamation and the remnants of chinampas cultivated in recent times. Some of the blank zones coincide with the location of old lagoons; in other sections, lack of data may be due to erasure of the evidence. Sections of the extant canals seem to have been realigned during the 19th century. (Abbreviations: C, cerro; V, volcan.)

of the ancient field system are shown as shadow marks on ground that has not been completely leveled by plowing (Fig. 4). Also, the parallax allows one to see on the stereographs the relief of the ridges formed by eroded chinampa strips, the low mounds where the farmhouses stood, and the shallow grooves that reveal the clogged ruts of old canals. Of course, only weed marks—produced by the differential growth of plants on the former plot and along the ditches—can be seen on repeatedly plowed surfaces; but it is in these sections that the palimpsest effect created by the overlaying of present field boundaries on the old chinampa grid is most strikingly shown by aerial photography (Fig. 5). Even without enlargement, the scale of the contact prints (approximately 1 : 5000) allows delimitation of separate farm units, through correlation between isolated farmsteads and blocks of chinampa strips, and makes it possible to measure with reasonable accuracy the size of the landholdings.

Old maps were consulted too, but none of the early ones helps to plot the extent of swamp reclamation in the

Xochimilco-Chalco Basin at the time of the Spanish conquest. The best mid-16th-century general chart of the Valley of Mexico (the pictorial map preserved at the University of Uppsala) portrays the tract of marshes and the layout of the main canals across them, as well as the island-towns and the causeways that linked Cuitlahuac to the mainland—but it does not depict the garden plots. The gross acreage of chinampas does not seem to have been delimited on maps until the 19th century, long after the upsetting of the ecosystem had reduced the areas of chinampa horticulture to a fraction of their peak size. Nevertheless, the search through old maps produced important information about hydrologic conditions before they were changed by artificial draining of the basin.

In several maps drafted during the 18th and 19th centuries, the areas of standing water within the zone of swamps were clearly demarcated. A comparison among different versions made over a 120-year period shows general agreement as to extent and location of the pools; these were permanent features determined by the relief

of the area. Obviously the information on water depths is important in my study. It is noteworthy that the distribution of ghosts of ancient chinampas on aerial photographs corresponds to the swamp zone represented on these 18th- and 19th-century maps, but such marks are missing on the old beds of major lagoons where deeper water precluded the building of raised plots.

The indications of past land use that one spots on the aerial photographs have to be identified and dated through the field survey, which must be performed on foot—one misses the “ground truth” when riding in a jeep. Walking over the surface of old chinampas, one can feel, through the soles of one’s boots, revealing differences in soil texture or the slight undulations of the ground. This is pedestrian archeology, but it works. On ground that has never been plowed, the raised strips of former chinampas can be seen to form parallel ridges that simulate a huge washboard, but in most places the ridges eroded or have been completely flattened by plowing after the area has become desiccated (Fig. 6). In general, the ghosts of the chinampas are outlined by rows of hydrophilic weeds, which thrive along the filled ditches between chinampas, or they may show as soil or moisture marks (depending on the season in which they are observed).



Fig. 3. Chinampa plots at Tlahuac, Federal District, Mexico. Seepage from the surrounding canals allows continuous use of the farmland.

### Swamp Dwellers in the Perspective of Time

Although lakeside settlements were numerous and important, it appears that in Aztec times a plurality of chinampa tillers dwelt in the middle of the swamps, rather than on the shore of the mainland. The island-towns of Mizquic, Cuitlahuac, and Xochimilco were mentioned by Cortes in his letters to Emperor Charles V (7). Mizquic was “a small town, completely set upon water,” at a distance of “almost two crossbow shots” from the shore; it had no walkways to the mainland. Cuitlahuac (described as “the best-looking small city we have seen”) was placed in the center of the basin, thus commanding waterborne transport through the arterial canals along the east-west axis. It was linked to the shores of the mainland to the north and south by causeways that were part of a major land route to Iztapalapa and thence to Tenochtitlan. These causeways still



stand. Xochimilco was close to the shore, on the outer side of a slough. Cortes alluded to "a broad causeway" and to bridges spanning "all the entrances to the city." These three towns are still standing on their old sites, and they have adjacent areas of chinampas. In addition, the ruins of Xicco rest on an apparently man-made platform abutting to an abrupt volcanic hill that formed a natural island in the eastern lobe of the basin. Xicco had been an important political center, and, according to native lore, was the mother city of the founders of Cuitlahuac.

Besides these island-towns, the watery landscape was dotted with small communities and dispersed farmsteads set on artificial foundations amid the chinampa plots (8). Nowadays, the sites of ancient islet dwellings are marked by low platform mounds and heavy concentrations of crockery. Where the ground has been leveled by plowing, circumscribed deposits of potsherds, and, perchance, a scattering of foundation rocks or lumps of burnt adobe,

reveal the ghosts of flattened house mounds (which may also be spotted as soil marks on aerial photographs taken at low altitudes). The fact that these sites are scattered over most of the former swamp zone facilitates the determination of the age of the surrounding chinampas—the vestiges can be associated with safely datable dwelling places. The samples of domestic pottery collected on the surface of 50 well-defined house sites were used to this end. The sampling units are broadly distributed within the swampy basin, and the ceramic assemblages are quite uniform in all of the units: the bulk of the material unequivocally dates occupancy to around A.D. 1500. Also, the time indicators show that the pattern of islet dwelling had spread during the span of a few lifetimes. The construction of these mounds was relatively recent: many of the ceramic lots include wares in vogue two or three centuries before the time of the Spanish conquest, but nothing definitely older was found in any of these sites (9). Neither

did excavation in the foundations of the man-made island of Cuitlahuac produce any indication of greater antiquity; as it stands, the limited evidence obtained in these test pits dates the earliest construction yet found there to the dawn of the Aztec period. All told (adding observations made all over the area in the course of the ground survey), the data conclusively show that the peak of chinampa expansion was attained during A.D. 1400 to 1600. The distribution plotted on the map (Fig. 2) represents the man-shaped landscape in Aztec times. In historical perspective, the evidence of the oldest ceramic components in samples from islet dwellings indicates that this pattern of dispersed settlement developed during the cycle of expansion initiated at the end of the Toltec period (13th century).

Nevertheless, settlement on man-made isles (presumably surrounded by chinampas) in the middle of the swamps had remote antecedents in this basin. This was conclusively established as the



Fig. 4. Shadow marks of old chinampas in a still unplowed section to the northeast of Xochimilco; the ridges at the upper left are shown in Fig. 6 (top). Approximate scale, 1 : 5000; the top of the photograph is the southeast. [Aerial photograph taken by Compañía Mexicana de Aerofoto]

result of my 1970 testing at a site located in the bottoms to the southwest of Tlaltenco (10). The site is made up of a fair-sized cluster of dwelling structures set on artificial foundations in what was then a shallow embayment of the lagoon. The excavation revealed that the construction of the isle antedated by several centuries the beginning of the Christian era and that its occupation came to an end before the onset of the Classic Teotihuacan period (about A.D. 1). More precise dating of this site must await processing of the information yielded by the stratigraphists. Another site within the lacustrine basin might prove to be ancient too, but it is still untested (11). At any rate, the paucity of remains dating to pre-Classic times suggests that the early wave of expansion into swamps was restricted in scope, being limited to choice locations because of either lack of population pressure on resources or dominant physical conditions that were less favorable for the setting of chinampas than those prevailing in Aztec times.

Large sites dating from the Teotihuacan and Toltec periods are located on the shores of the mainland and on the island of Xicco; the townfolk might have farmed nearby chinampas, although I do not yet have proof that they did so. However that may be, no time markers for these periods were found in indisputable association with vestiges of offshore settlement. In view of the evidence for an earlier beginning, it would seem that swamp reclamation receded to a minimum during the long interval from A.D. 1 to 1200; the most likely cause of the recession was hydrographic changes in the basin. I postulate that the water level rose, resulting in the spread and coalescence of standing ponds to form a large lagoon that completely filled the bottom of the basin. This would have restricted the setting for chinampas to the remaining marshland near the shore. Later on, the reversal of the trend led to the rapid expansion of reclamation in Aztec times. It seems that optimal conditions obtained through the 16th century,

since it is documented that chinampa construction was going on decades after the arrival of the Spaniards. However, this hypothesis must be tested by further archeological investigations and paleolimnological research.

#### The Setting for Raised Gardens

The relief of the bottom and the volume of standing water were the physical factors that controlled chinampa expansion in the Xochimilco-Chalco Basin (12). The bottom of the basin is shaped like an exceedingly shallow saucer. This even-floored depression is confined by a ground rise that forms a low bank along most of the circuit; the break-of-slope approximately coincides with the 2240-meter contour line. Only the gentle slopes on the eastern shore and a limited fringe at the western end are susceptible to flooding by a moderate rise above this level. The rim of the high ground is studded with a score of towns and villages. These settlements



Fig. 5. Weed marks of old chinampas in plowed fields. Notice the parallel alignments of marks and the blocks outlined by former service canals at the bottom of the picture. Approximate scale, 1 : 5000; the top of the photograph is the southeast. [Aerial photograph taken by Compañía Mexicana de Aerofoto]

have been tenanted since Aztec times or before; older sites too, long deserted, define this ancient shoreline. The persistence of location indicates that, except for disastrous flood stages, the high-water mark has stood close to the 2240-meter elevation since at least several centuries before the beginning of the Christian era. Within the ambit enclosed by the ground rise, the present elevation of the flats generally ranges between 2238 and 2239 meters, although the depths reach 2236 meters in the area of the old Lagoon of Ayotla (depicted in 18th- and 19th-century maps). Admittedly, these figures may be at variance with past values. Floor levels might have been raised through silting (since, for the most part, the zone was under water until the end of the 19th century), but, on the other hand, this effect may have been compensated for by ground subsidence after the desiccation of the basin. Be that as it may, old maps and archeological evidence indicate that changes in floor relief through the last 600 years have been of minor consequence.

The topographic data clearly show that a rise in water level above 2240 meters would flood the whole plain, forming a shallow lake some 180 to 200 square kilometers in size (13); below that mark, large lagoons would be interspersed among tracts of swampland; a water level under 2238 meters would reduce the areas of standing water to a sizable lagoon (on the deeper ground to the southwest of Ayotla) and a number of scattered pools. This poses the question: What environmental conditions spurred chinampa expansion in Aztec times? With this in mind, the level of the normal high-water mark in the Aztec period (from the 14th to the 16th centuries) was tested through my 1968 excavations at Tlahuac (ancient Cuitlahuac). In the test pits that were dug to investigate the structure of the man-made island, construction floors and wall stumps dating from Aztec times (14) were found at depths which indicate that the lagoon level in the rainy season was less than 2238.8 meters (which is the level of the floor in the lowest dwelling) when building began there (15). The landfill for the foundations was piled on an evenly laid base of cut cattails that rested on a stratum of mud rich in vegetal matter—probably marsh sediment (16). The cattail carpet is at 2238.4 meters; the ground level for later structures was progressively raised by the addition of

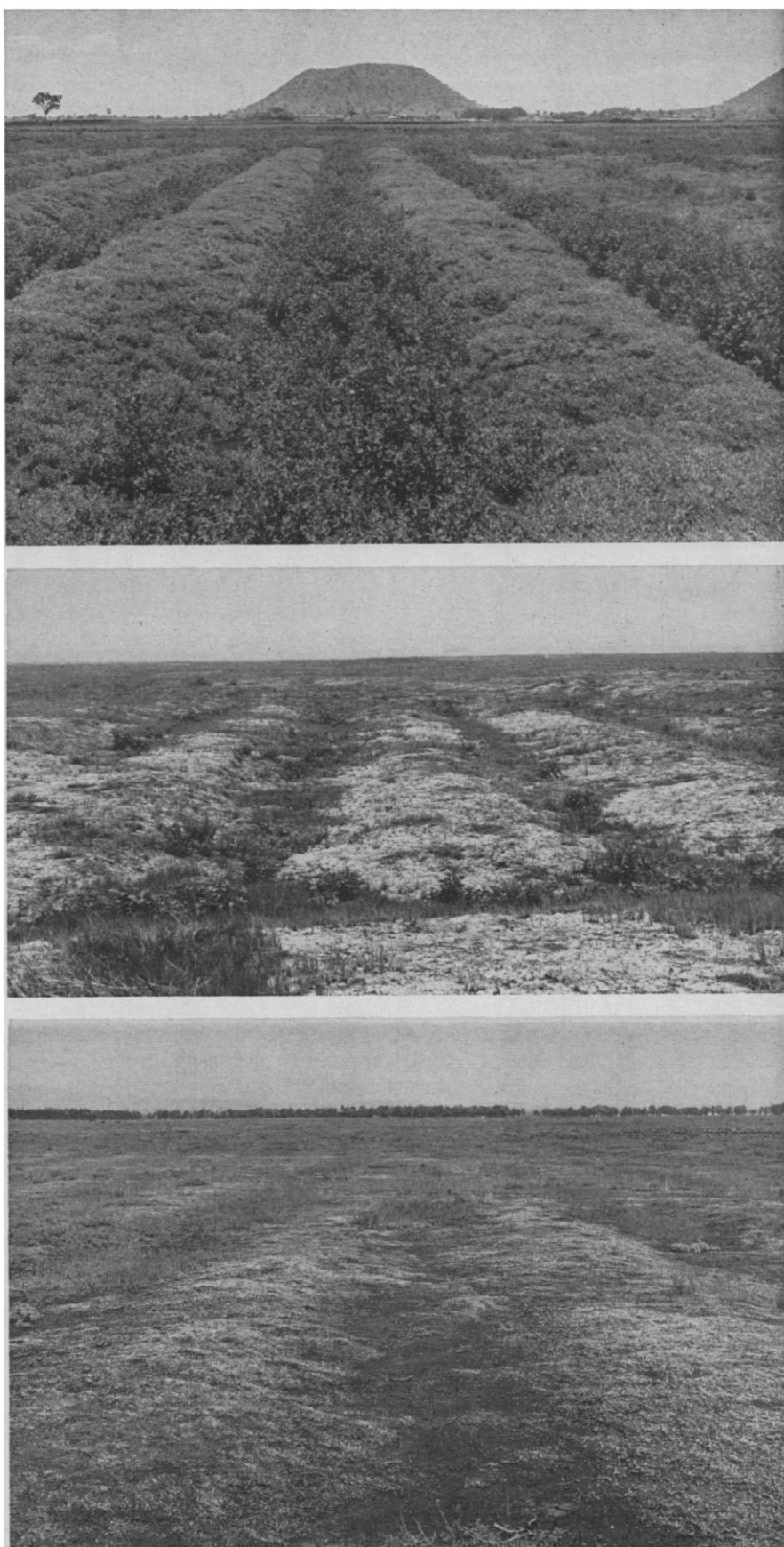


Fig. 6. Three stages of obliteration of the evidence of old chinampas: (top) well-preserved ridges and plowed area, to the right, with parallel alignments of hydrophilic weeds; (middle) eroded ridges outlined by the vegetation growing on the intervening ditches; (bottom) leveled ground showing traces of chinampas, largely by means of soil contrast. In all of the pictures, the average width between the canal medians measures 4.8 meters.

landfill, so that the floor of the latest pre-Colonial building (in the excavated area) was laid at 2240.2 meters (17). (Caveat: Although precisely determined by leveling from a bench mark on the mainland, the figures for elevations at the time of construction must be viewed as approximations, owing to the possibility that the old lake bed has subsided because of the recent depletion of the aquifers. However that may be, one can safely posit, on the basis of geomorphological considerations, that the extent of subsidence has been not more than 1 meter.) Correlating all these figures, and allowing for seasonal and yearly variations in the range of 0.8 to 1.4 meters (18), it follows that the chinampas were built on what was swampy ground at the end of the dry seasons (although a number of large pools and extensive backwater areas, connected by a maze of sloughs, were undoubtedly permanent features of the natural landscape, even through the driest years). The correspondence between the distribution of chinampa ghosts and the extent of the swamps shows that the garden plot builders avoided the deeper waters.

### Chinampas and Polity

Consideration of the formal features of the man-shaped landscape in the early 1500's suggests that the late pre-Columbian expansion of swamp reclamation over the Xochimilco-Chalco Basin reflects planned enterprise rather than spontaneous initiative. The comprehensive view of traces of old chinampas afforded by the aerial photomaps incontestably shows that the layout of plots was regulated by some overall scheme. Generally, the chinampas that can be dated to Aztec times were built in sets that were arrayed within the rectangular blocks delimited by the grid of service canals. Distances between the limiting canals are not uniform everywhere, but they fit in patterns that indicate some sort of modular system in the allotment of space (19). A series of parallel alignments of regularly spaced service canals can be traced from shore to shore all over the Xochimilco section of the basin and, in less extensive areas, within the Chalco lobe. From end to end, the pattern is definitely oriented along south-southwest to north-northeast axes (20). On the basis of indicia observed at ground

level, I expect that aerial photography with infrared wavelengths (which has not been used yet to survey the basin) will reveal enough marks of the grid to fill the gaps between Mizquic and Xicco and between Xicco and Tlahuac. Whether the systematic allotment of space for chinampas within a frame of parallel axes followed earlier models, or whether the regulating plan represents an innovation fostered by the changes in political organization that occurred during the 15th century, has not yet been ascertained. It seems rather improbable, however, that a regular layout, extending without major discordances from end to end of the basin, could have resulted from community agreements to adjust the coalescent local systems. As I see it, the pattern of chinampa expansion in Aztec times betokens control at a higher political level.

Although the Valley of Mexico included other prime agricultural districts, none seems to have matched the productivity of the continuous zone of chinampa farming in the Xochimilco-Chalco Basin. The economic importance of the district, in the context of the Valley of Mexico as a whole, can be gauged with the help of a few figures. The gross area of reclaimed swamps, excluding islands, amounted to more than 120 square kilometers. Reducing this figure by one-fourth—to account for canals and an indeterminate number of interspersed pools—we are left with over 9000 hectares of productive soil built upon natural wastes. The yields of this farming system per unit of tilled land are extremely high (21); according to empirically derived figures on the subsistence potential of chinampa horticulture, the zone may have produced enough food to nourish some 100,000 people. Certainly not all of the output was consumed locally; my data on plot sizes suggest that over one-half of the food raised on these gardens was available for distribution among nonfarming consumers. There is conclusive historical evidence that, through tribute and rent, and through the market system, the surpluses produced in this zone significantly contributed to the support of urban life at the empire's hub. The advantages of its location for the movement of produce to the centers of consumption accrued to the importance of the zone; waterborne transportation, through the network of canals and expanses of open water, provided direct routes by boat

from the places of production to the docks of the Aztec capital city Tenochtitlan and her annex Tlatelolco, the site of the central market.

In historical perspective, the creation of farmland over marshes and lagoons in the Valley of Mexico represents the ultimate development of its natural resources through aboriginal technology. The high productivity of chinampa horticulture considerably enlarged the basis of subsistence of the local population. This might have been the breakthrough that finally made this region a key economic area. Anyhow, the expansion of chinampa farming during the 14th and 15th centuries (22) appears to be related to a substantial increase in population. On the eve of the Spanish conquest, this heartland of empire greatly outranged in human resources any other center of power within the sphere of Mexican civilization (5, p. 268). Since the mid 1400's (when unity and stability were achieved under a confederal system that brought to an end a period of conflict between contending city-states), the rulers of the alliance controlled formidable reserves of manpower for engaging in military expansionist adventures, as they did. In this light, it can be said that the material foundations for Aztec imperialism were established by the farmers who had conquered the swamps.

### References and Notes

1. Fr. J. de Torquemada, *Monarquía Indiana* (Madrid, 1723), book 13, chap. 32.
2. B. de Vargas Machuca, *Milicia y descripción de las Yndias* (Madrid, 1599).
3. *Relación breve y verdadera de algunas cosas de los muchos que sucedieron al Padre Alonso Ponce en las provincias de la Nueva España* (Madrid, 1723), book 13, chap. 32.
4. Fr. H. Ojea, *Libro tercero de la historia religiosa de la Provincia de México de la Orden de Santo Domingo* (Mexico, 1897), p. 3.
5. P. Armillas, in *A History of Land Use in Arid Regions*, L. Dudley Stamp, Ed. (UNESCO, Paris, 1961), pp. 266-267.
6. See O. G. S. Crawford, *Archaeology in the Field* (Phoenix House, London, 1953), p. 51. Also, I am intellectually indebted to J. Bradford [Ancient Landscapes (Bell, London, 1957)] for many of the concepts expressed in my formulation. Studies in landscape archeology are well advanced in several parts of the Old World; in the New World the approach has been pioneered by G. R. Willey [*Prehistoric Settlement Patterns in the Viru Valley, Peru* (Bureau of American Ethnology Bulletin No. 155, Smithsonian Institution, Washington, D.C., 1953)].
7. *Letters of Cortez: The Five Letters of Relation from Hernando Cortes to the Emperor, Charles V*, translated by F. A. Macnutt (Putnam, New York, 1908). The references to Mizquic and Cuitlahuac are found in the second letter, written in 1520, Xochimilco is mentioned in the third letter, written in 1522.
8. See Vargas Machuca (2): "A large number of Indians dwell inside the lagoon; they make staked enclosures and fill these with earth to some height above the water, and built their houses on top."
9. Plain kitchenware (including an exceedingly



- large number of earthen griddles, which attest to generous consumption of tortillas) constitutes the largest percentage of shards found in the debris. The bulk of the decorated dinnerware belongs to the so-called Aztec black-on-orange series. Of these, the fine line, geometric, "Tenochtitlan" type is present in all of the samples in a significant percentage. The chronologically overlapping "Tlatelolco" figurative style occurs in a majority of the lots, but it surpasses the frequency of the "Tenochtitlan" type only in some collection from large homesites that might have been principals' houses. The earlier, cursive, "Tena-yuca" style appears in token or small amounts in about three out of four sites, and the still older "Culhuacan" bold line style is concentrated in locations close to the shore of Xicco Island (this type is rarely found in dispersed homesites). Other fineware associated with the Aztec black-on-orange include Aztec polychrome and Chalco polychrome, but the incidence of the latter is relatively small and spotty. Nothing definitely older than the black-on-orange series was found in any of these sites. On the other hand, a few Early Colonial glazed shards, a figurine, and a glass bead picked up in scattered places attest to the persistence of this pattern of dispersed settlement after the Spanish conquest—probably until the beginning of the 17th century.
10. Site location: 14QMS972324 (Universal Transverse Mercator Grid); a range of flattop mounds rising about 2 meters above the surrounding plain. Test excavations at its eastern end exposed dwelling structures resting on a foundation of large rocks set on swampy bottoms. Upright pine logs (driven deep into the lake bed) reinforced in some spots the banks of this man-made island.
  11. Site location 14QMS997292 (about 1 kilometer south of the edge of Tlahuac); a plowed bulge (about 80 meters in diameter) carpeted with potsherds similar to those found in site 14QMS972324.
  12. Salinity, which limited the spread in Lake Tezcoco, does not seem to be of consequence here.
  13. A high stage began about 1600; it was caused by the blocking of the outlets that discharged into Lake Tezcoco—one of the many Early Colonial attempts to protect Mexico City from floods caused by the upsurging of that lake. The effects were disastrous for swamp farming; the rising waters submerged the chinampas and forced the lagoon dwellers to move out [see Torquemada (7)]. A rise above 2241 meters was detected in the test pits at Tlahuac; it flooded houses that were tenanted in the early 1500's and caused the collapse of the walls, leaving over the rubble a layer of silt that underlies deposits containing potsherds dated to the 17th century. This rise must have reached a temporary high mark at about 2243 meters, in view of the evidence (found by inspectors of the Dirección de Monumentos Coloniales) of a flood that laid silt deposits above the 16th-century foundations of the parish church (Architect Luis Ortiz Macedo, personal communication).
  14. This is on the evidence of underlying fill containing shards of "Tenochtitlan" black-on-orange and associated wares.
  15. The 1970 excavations at site 14QMS972324 showed that, some centuries B.C., the high-water mark stood perhaps somewhat higher than in Aztec times—but certainly below 2239.8 meters, since house floors were laid at this level.
  16. Two wooden pegs, found imbedded in the landfill, appear to have strengthened this structure.
  17. Several of the layers of landfill, found in the main testing pit under superimposed floors, contained only potsherds and terra-cotta figurines of the Middle Formative period (about 600 to 800 B.C.). Since these deposits overlaid structures firmly dated at the 14th or the 15th centuries A.D., it is evident that the rubble used to raise the foundations was borrowed from an old abandoned site. A Middle Formative site located by J. R. Parsons (personal communication) at the village of Tlaltenco, on the mainland to the north, might have been the source of the rubble used in Aztec times to build up the island.
  18. This is assumed on the basis of recent records of the control station at Xochimilco [see Comisión Hidrológica de la Cuenca del Valle de México, *Hidrología de la Cuenca del Valle de México* (Secretaría de Recursos Hidráulicos, México, D.F., 1964), vol. 6, pp. 16 and 191]. A large number of historical documents, including pre-Hispanic annals, refer to broad-scale fluctuations of the level of the lakes—fluctuations large enough to drown chinampas, flood island settlements, and alter the hydrologic balance to the extent of reversing the flow between the interconnected lakes.
  19. Around the nodes formed by the former islands of Cuitlahuac and Mizquic and, to a lesser extent, in the immediate vicinity of Xochimilco, this pattern was blurred by the radial cobweb of through-traffic canals that converged on these centers. This was most true around Mizquic, where the layout still conforms to a basically radial pattern. The lack of regular grid in the surroundings of these centers leads me to infer that the perisland chinampas were built before the adoption of the regulating plan. However, some regular alignments of canal stretches can be traced across the mazes formed by the surviving chinampas at Xochimilco and at Tlahuac—which suggests that the present irregular layout may be partially the result of alterations that followed the breakdown of the system, probably after 1600.
  20. Of course, visual alignment across 5 kilometers of flooded ground will seldom produce perfect parallels. Over most of the area, azimuthal deviations run from 18° to 26° clockwise from the astronomic north; the modal orientation stands close to 22°. However, to the north of Xochimilco the deviations vary between 12° and 18°; and, to the west of Xicco, the azimuths of a series of canals run 14° from the true north. Whether the orientation of the grid was dictated on the basis of cosmological notions, or whether it was adjusted to established traffic patterns determined by the natural drainage of the basin, is a matter of opinion. Certainly, the general aerial maps show that, in the central and eastern sections of the basin, the layout of feeder canals runs approximately perpendicular to the courses of the arterial transport routes, whereas at the western end it is deflected toward the old outlets to Lake Tezcoco.
  21. W. T. Sanders, thesis, Harvard University (1957).
  22. In addition to the swamps in the Xochimilco-Chalco Basin, smaller (but considerable) sections of Lake Tezcoco and the Lagoon of Xaltocan had been reclaimed for chinampa farming.
  23. Field surveys 1965 to 1967 supported by NSF grant GS-890; test excavations (1968 and 1970), by grants-in-aid from the Wenner-Gren Foundation for Anthropological Research, Southern Illinois University (1965) and the University of Chicago (1966 and 1967) contributed research time. I gratefully acknowledge the support of Mexico's Instituto Nacional de Antropología e Historia; I thank J. L. Lorenzo, head of the Dirección de Prehistoria, for helpful advice, for the use of the department's laboratory facilities and equipment, and for the valuable assistance of members of the department's staff, R. Arana, T. Alvarez, and A. Flores, who, respectively, supervised the excavations, identified bones, and analyzed soils.