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# Human role in shaping of the flora in a wetland community, the chinampa

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ABSTRACT

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Wetfield agriculture was extensively practised in Mexico in prehispanic times and continues to be an important agricultural method in the Valley of Mexico where it is known as the chinampa farming system. In this paper we discuss the importance of vegetation management in the chinampa agricultural system and what goods and services the flora can provide for direct and indirect human use in a sustainable form while conserving the environment. The use of the chinampa agro-ecosystem for in situ conservation of germplasm is proposed.

## INTRODUCTION

Recently there has been increasing interest in the development of viable alternatives to the costly attempts to drain and convert natural wetlands to dry land agriculture in temperate and tropical regions. In our search for alternatives for wetland development, we might consider some successful techniques from the past as a suitable guide for the future (Gomez-Pompa, 1978). Wetlands have played a key role in the development and maintenance of some of the most successful ancient cultures of the New World, such as the Mayans (Siemens and Puleston, 1972), the Aztecs (Coe, 1964) and the Incas (Erickson, 1986), but we know very little about how these systems were managed. The only contemporary example is an agro-ecosystem in Mexico which is inherited from ancient times and is still in use: the chinampa*. This ancient wetland agro-ecosystem has been working continuously for at least 1000 years (Armillas, 1971). Chinampa agriculture provides an excellent example of an efficient and self-sustaining agricultural system in which productivity is enhanced by the management of biodiversity. Knowledge about the ecological interactions occurring within the chinampa agricultural system and the sustained functioning of this system promise exciting advances in the design of sustainable agro-ecosystems (Jiménez-Osornio et al., 1988).

The chinampa system has been sustainable since prehispanic times mainly because the Chinampanecas** have functioned as an integral part of the agro-ecosystem; through time they have been effective designers and internal controllers (Jiménez-Osornio and del Amo, 1988). Chinampanecas have managed the essential components of the system – the water,

*Chinampa: Nahuatl word, its meaning is "net of branches". It is essentially a strip of land surrounded by water.

**Chinampaneca: people that inhabit the chinampa towns (Sahagun, 1950–1969).

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the soil, and the biological resources – through a series of complex techniques based on the accumulated knowledge of millennia (Armillas, 1971). This paper discusses the management of the vegetation and flora in the chinampa agro-ecosystem.

Vegetation in agricultural systems can be viewed as an assemblage of plants growing together that displays the effects of environmental conditions, ecological interactions, and human management. The flora in any managed system is affected by these three factors or determined by some combination of the factors.

In most modern agro-ecosystems, the management of the flora consists merely of the reduction of the number of crop species to be managed and the eradication of weeds by mechanical or chemical means. The ultimate goal is a single species ecosystem. In contrast, many traditional agro-ecosystems include the management of many species in the same field and also the use of species for multiple purposes (Altieri et al., 1987). In the case of the chinampas it was observed that the diversity was very high, but no data about the management of the entire flora were available. In addition, we knew that the Chinampanecas do not have a concept for weeds (Jiménez-Osornio and del Amo, 1988), despite the fact that they have many species in their agricultural fields that are commonly known elsewhere as noxious weeds. For these reasons we began a project, The Ethnoflora Chinampera, to better understand the management system of the plants by the Chinampanecas.

## METHODS AND STUDY AREA

For this study we selected the chinampa town of San Andrés Mixquic, Mexico, whose economy is based on agriculture (Colliere, 1981). San Andrés Mixquic is a small semi-rural chinampa town located 40 km from Mexico City at an altitude of 2269 m. The average rainfall is between 600 and 700 mm and occurs in the summer months. The annual mean temperature is 15°C. The extant chinampas were part of Chalco Lake and today the water supply comes from a few remaining springs and treated sewage from Mexico City. To initiate the process of gathering local knowledge on the chinampa flora, several Chinampanecas were interviewed. All flowering plants were identified. Herbarium specimens of all non-domesticated* species have been deposited at the herbarium of the University of California, Riverside.

## RESULTS

We have registered 146 different plant species in the chinampa region of San Andrés Mixquic, belonging to 36 angiosperm families (Table 1). There are 51 domesticated species; several of these species have varieties that are used for intercropping or for planting in different seasons. An outstanding finding was the discovery of the process of careful selection of high-performing seeds of several commercial crops that have been developed locally and also marketed internally. This is an extraordinary example of the process of crop evolution in one single locality and in a man-made wetland environment.

Plant diversity in space and time in this farming system is remarkable. For example, in our most recent vegetation analysis (November, 1988) we found that one Chinampaneca, Don Pedro Nuñez, had 20 domesticated species and 30 non-domesticated species growing in his chinampa fields which measure an estimated 2270 $m^2$.

The main cash crops growing in the chinampas of San Andrés Mixquic are swiss chard (*Beta vulgaris* L. var. 'cycla'), broccoli (*Brassica oleracea* L. var. 'italica') and celery (*Apium graveolens* L.) (Table 1). Two of the domesticated species with multiple uses are: corn (*Zea mays* L.) and squash (*Cucurbita* spp.). Corn can be used as a vegetable or as a

*Non-domesticated: plants that have not been consciently selected by man.

TABLE 1

Families of domesticated and non-domesticated plants and number of species within each family collected in the chinampas from San Andrés Mixquic, México

| Family | No. of different species | | Use(s)[1] |
|---|---|---|---|
| | Domesticated | Non-domesticated | |
| Alismataceae | – | 1 | 1,10 |
| Araceae | 1 | – | 1,10 |
| Amaranthaceae | 1 | 2 | 1,2,4 |
| Asteraceae | 8 | 14 | 1,2,3,4,7,10 |
| Boraginaceae | – | 1 | 2,11 |
| Brassicaceae | 7 | 9 | 1,2,3,10 |
| Cactaceae | 1 | – | 1 |
| Caryophyllaceae | 2 | 1 | 4,7,10 |
| Convolvulaceae | – | 1 | 2,4,7 |
| Cucurbitaceae | 4 | – | 1,5,10 |
| Cyperaceae | – | 3 | 1,2,8,11 |
| Chenopodiaceae | 4 | 10 | 1,2,3,10 |
| Fabaceae | 4 | 2 | 1,2 |
| Hydrocharitaceae | – | 1 | 2 |
| Labiatae | 2 | 2 | 1,2,6,9 |
| Liliaceae | 3 | – | 1,6,10 |
| Loganiaceae | – | 1 | |
| Malvaceae | – | 2 | 1,2,3,4 |
| Onagraceae | 1 | – | 4 |
| Oxalidaceae | – | 1 | 2 |
| Papaveraceae | – | 1 | 4,10 |
| Phytolacaceae | – | 1 | 2,11 |
| Plantaginaceae | – | 1 | 3 |
| Poaceae | 2 | 17 | 1,2,8,10,11 |
| Polygonaceae | – | 6 | 1,2,3 |
| Ponteridaceae | – | 1 | 2 |
| Portulacaceae | – | 1 | 1,10 |
| Ranunculaceae | – | 1 | |
| Rosaceae | 2 | 1 | 1 |
| Rutaceae | – | 1 | 3,11 |
| Salicacea | – | 1 | 2,8,11 |
| Solanaceae | 4 | 7 | 1,2,3 |
| Umbelliferae | 4 | 3 | 1,2,3,10 |
| Urticaceae | – | 1 | 2,3,6 |
| Violaceae | 1 | – | 4,10 |
| Unknown | – | 2 | 3 |
| Total | 51 | 96 | |

1, food; 2, fodder; 3, medicinal; 4, ornamental; 5, weed controller; 6, insecticide; 7, soil indicator; 8, mulch; 9, aromatic; 10, cash crop; 11, other.

grain while the stalks are used as fodder. Furthermore, the thicker stalks and roots are used as firewood. Squash male flowers are eaten or sold, the immature fruits can be eaten as vegetables, the mature fruits are utilized to prepare candies, and the seeds are also eaten. In addition, according to the Chinampanecas, squash is a good grass controller.

A major component of the flora in the chinampas are non-domesticated plants; 96 of the species collected belong to this category (Table 1). Amazingly, only six species have no identifiable use. The remaining non-domesticated flora may be utilized as fodder (67%), medicinals (20%) and food (13%). Other non-domesticated species are useful as ornamentals, aromatics, mulches, and pesticides. Some of the non-domesticated species are cultivated, such as *Suaeda terreyana* (romeritos), and *Portulaca oleracea* (verdolaga). Others are encouraged to grow, such as *Chenopodium ambrosioides* and *Sonchus oleraceus* (lechuguilla).

We found one plant species, *Circium lomatolepis* (Carlos Santo), that has only been collected in the Valley of Mexico and is in danger of extinction (Rzedowski and Rzedowski, 1985). We collected a native crop species "chia" (*Salvia hispanica*), which was used in prehispanic times, but today it is not cultivated and is rarely found in the Valley of Mexico (Rzedowski and Rzedowski, 1985). There is also a non-domesticated corn relative (*Zea mexicana*) that is encouraged to grow in the chinampas. This species is used as fodder and it may interchange genes with corn cultivars. Most of the people interviewed mention that there were many other non-domesticated species that they used to eat, but because of the change in water quality and quantity, these have disappeared.

## DISCUSSION

Like most wetlands, the chinampa landscape presents a great variety of habitats. The biological diversity of the chinampas is the result of the combination of many different domesticated species grown with non-domesticated plants (aquatic and terrestrial) that grow in the fields and nearby channels.

There have been many changes in the flora of the chinampa agro-ecosystem since prehispanic times but the plant resources have

evolved under the control of the Chinampanecas. The most important historical event affecting the biological resources of the chinampa region was the Spanish conquest in 1521 and the subsequent introduction of new crops from Europe. On the other hand, the most important factor affecting the system today is the diversion of water from the chinampa region to Mexico City (Outerbridge, 1987). It is important to point out that these changes have been imposed on the Chinampanecas and not produced by them.

Vegetation management in the chinampas is adapted to locally defined variables that are not only ecological but also economic. It seems that new domesticated species have been incorporated into the system without replacing previous crops, increasing the richness of the germplasm. Today the main cash crops planted in the chinampas of Mixquic are introduced, but we still find the five main native crops known to be used by the Aztecs (Sahagun, 1950–1969): maize, beans, chia, amaranth and squash. Although chia was nutritionally important as well as a valuable oilseed in prehispanic times (K. Truman, unpublished data, 1988), it is not cultivated any more in San Andrés Mixquic.

It is evident that non-domesticated plants are seen by the people of San Andrés Mixquic as a resource to be managed, not only for their ecological characteristics, but also because non-domesticated plant species are very important in the diet of both humans and domestic animals. However, the Chinampanecas recognize that there is a critical period in which non-crop plants need to be removed, which varies according to the crop. According to Venegas (1978) crop yields in the chinampas are higher than many of the modern agricultural systems practised in Mexico. If we add to this the production of non-domesticated species it might be the most productive agro-ecosystem ever known.

We should not forget that the key factor in the success of the chinampa technology has been the Chinampanecas and their culture. This is very important to understand if one wants to introduce this technology to other cultures and other ecological environments. The experience in the Mexican tropics has clearly shown us that successes (Brown, 1988; Gomez-Pompa and Jiménez-Osornio, 1990) and failures (Chapin, 1988) can be understood not only by the technology, but by considering the local needs and culture also.

The principles involved in the chinampa system may be one of the best alternatives for the development of wetlands, especially in the developing countries where capital is scarce, unemployment is abundant, and wetlands are being destroyed. We cannot exchange development and a better life for the inhabitants of these areas just for the sake of biological conservation. We need to be able to offer alternatives that allow both development and improvement of the environment. The challenge for us is how to learn from the chinampas in order to design and manage developmental schemes adapted to the environmental and cultural conditions of wetlands (Gliessman, 1988).

We must understand that progress is not pursued only through increasing applications of science and technology. An urgent need is to inform and continually educate planners, politicians and decision-makers about the value of wetlands to society and especially how the wetlands can be maintained while simultaneously attempting to meet the legitimate development needs of human communities (Maltby, 1988).

The chinampas of the Valley of Mexico have impressed many scientists for a long time and they have been designated as one of the World Heritage Sites of UNESCO. Unfortunately, those primarily responsible for the successful functioning of the system, the Chinampanecas, have not been consulted in the planning process and also have not received any benefits from UNESCO designation. The system is being disrupted at an increasing rate by urban

development, pollution and diversion of the water supply. Novelo and Gallegos (1988) found that in the last 15 years at least 20 plant species have disappeared from the chinampa towns of Xochimilco and Mixquic. Most of the plants were part of the diet of local people.

We believe that economic incentives need to be given to the Chinampanecas who have maintained this treasure despite the pressures for development, and that the system can be improved with modern knowledge. This will encourage the Chinampanecas who still work their fields to maintain and improve their chinampas and it will attract others who have already abandoned this lifestyle.

To our knowledge, chinampas are the biologically richest agro-ecosystem known today in which most of the flora is managed and used. The stability and sustainability of the chinampa agricultural system is based on the maintenance of a high level of biodiversity; this system represents a sensible strategy to preserve in situ repositories of germplasm of both domesticated and non-domesticated species.

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