Available online at www.sciencedirect.com
ScienceDirect
Agriculture, Ecosystems and Environment 121 (2007) 211–221
Agriculture Ecosystems & Environment
www.elsevier.com/locate/agee

A maize landscape: Ethnicity and agro-biodiversity in Chiapas Mexico

S.B. Brush [a,*], Hugo R. Perales [b]

[a] Department of Human and Community Development, University of California, Davis, CA 95616, United States
[b] Departamento de Agroecología, El Colegio de la Frontera Sur, Carretera Panamericana y Periférico Sur s/n, San Cristóbal, Chiapas, México 29290, Mexico

Available online 31 January 2007

Abstract

The ecology of maize (*Zea mays* L.) in Mexico, its center of domestication and diversity, has been researched for several decades. While the broad outlines of diversity and dynamics of native maize populations are known at the farm and national levels, these topics are less well known at the landscape level. Although environmental factors are the principal forces behind the overall diversity of the species in Mexico, recent research suggests that social origin, for instance community of residence or ethno-linguistic group, influences maize population structure at more local levels. A landscape perspective can help to determine whether these social factors operate in a consistent fashion across different environments. Case study data from Chiapas are presented and used to illustrate the role of ethnicity in understanding the ecology of maize diversity in Mexico. The paper contrasts the maize populations and management practices of Spanish speaking mestizos and Mayan language speaking indigenous people across four altitude zones in Chiapas. Environmental differences are primary in determining the overall pattern of maize diversity across the Chiapan landscape, but social origin has a significant effect on maize populations in all environments.

Keywords: Crop diversity; Agriculture; Indigenous people; Mestizos

1. Introduction

The purpose of this paper is to examine the effect of social origin on patterns of maize (*Zea mays* L.) diversity at a landscape level between the extremes of the national and community levels. Among other aspects, analysis of Mexican maize diversity at the national and community levels has focused on the overall structure of the species (e.g., Sánchez et al., 2000), the distribution of diversity across different environments (Perales et al., 2003a), and competition between landraces and modern varieties (Bellon and Brush, 1994). Early research (e.g., Anderson, 1947) established that maize diversity is not randomly distributed but rather is a function of environmental factors. Systematic collection and analysis has confirmed that ecology, determined by altitude and geographic location, explains the distribution of the 59 races of maize in Mexico (Sánchez and Goodman, 1992). In this, Mexican maize follows a familiar pattern to the biogeography of other organisms (Rosenzweig, 1995) and crops (Frankel et al., 1995) in which spatial distribution across bio-physical environments accounts for diversity. Although Mexico has undergone modernization in many regards, its maize crop is primarily sown with local seed. The use of improved varieties from public and commercial breeding is confined to a relatively small percentage of Mexican maize area, primarily in the intensive cropping systems below 1200 m above sea level (m a.s.l.) (Aquino et al., 2001).

Research on the diversity and dynamics of Mexican maize has focused primarily at two levels at different spatial extremes. The overall diversity of the species has been studied from national collections and material from relatively few farmers obtained without social context (Wellhausen et al., 1952). At the other extreme, the selection and maintenance of maize has been examined at the local or micro-regional level and reliant on relatively intensive collecting and surveying of farm households (e.g., Bellon and Brush, 1994; Perales et al., 2003a). One important study that is focused between the national and local levels is

* Corresponding author. Tel.: +1 530 752 4368; fax: +1 530 752 5660.
E-mail address: sbbrush@ucdavis.edu (S.B. Brush).

0167-8809/$ – see front matter
doi:10.1016/j.agee.2006.12.018

Aguirre et al. (2000) analysis of maize diversity in southeastern Guanajuato. Aguirre et al. (2000) examed such landscape variables as economic infrastructure and agronomic potential in relation to maize types. Other landscape variables that are important elsewhere in Mexico, such as contrasting, altitude related environments and the ethnic composition of different towns and villages, were not considered as they are in this study.

Good theoretical grounds exist for studying crop ecology at the landscape level (Veldkamp et al., 2001). Arguably, crop evolution needs to be understood at different spatial scales. Larger scales, such as the nation and its major eco-geographic regions, are useful when natural selection is the objective of research. When artificial selection is the object, a smaller scale is useful. Conscious selection is ultimately the product of individual actors, although individuals act in concert with shared knowledge systems and markets that extend beyond the community. Moreover sharing of seed among farmers results in the pooling of individual actions and locations. The combination of social factors above the individual level and pooling through seed networks bids us to work at higher levels than the individual or single village. Because contrasts among crops, environments, and social groups are most discernable at the landscape level, the impact of artificial selection on crop diversity can most readily be identified and triangulated at that level.

While ecological factors play a dominant role in the distribution and structure of maize diversity, several research findings suggest that social factors contribute to maize diversity at the landscape level. Location specific research (e.g., Bellon and Brush, 1994) suggests that maize diversity is found primarily between communities rather than within them. Hernández (1985) emphasizes the association between maize diversity and uses by different ethnic groups across various regions. Maize landraces are partly the product of seed exchange beyond the community (Louette et al., 1997). Pressoir and Berthaud (2004b) and Perales et al. (2005) find that population structure measured by morphological and agronomic traits is a function of different communities and ethno-linguistic groups in relatively small regions. Finally, several researchers have found that different regions are more or less dynamic in terms of the number of landraces present, farmer activities directed at changing landraces, and the replacement of local populations with modern varieties (e.g., Aguirre et al., 2000; Perales et al., 2003b). This paper builds on previous research by expanding the scale for understanding maize diversity in relation to human components.

2. Distribution and structure of maize diversity in Mexico

2.1. Races of maize

The historic unit of analysis of maize diversity has been race, defined by Anderson and Cutler (1942) as ''a group of individuals with a significant number of genes in common, major races have a smaller number in common than do sub-races.'' Using plant, ear and tassel characteristics as well as physiological, genetic, and cytological characteristics Wellhausen et al. (1952) analyzed their countrywide collection to described 25 Mexican maize races. Continued collection and new methodologies, such as isozyme analysis, have increased that number to 59 (Sánchez et al., 2000). Variation within races is evident when measured by quantitative and agronomic measures (Herrera-Cabrera et al., 2004; Pressoir and Berthaud, 2004b). Although the use of molecular markers to study population structure of Mexican maize is limited to the study of single races (Pressoir and Berthaud, 2004a), research with these tools on the background of U.S. maize suggests that racial complexes are distinguishable at the molecular level (Ho et al., 2005). Race remains the unit of classification for analysis of maize populations in Mexico.

2.2. Maize biogeography and ecology

Work of Anderson (1947), Wellhausen et al. (1952), Mangelsdorf (1974) and Hernández (1985) in Mexico and Guatemala laid the foundations of our contemporary understanding of maize biogeography in Mesoamerica. This research describes continuous variation among domesticated maize, although regional clusters or complexes are apparent, each comprising several races that are more closely allied with one another and genetically more distant from races in other clusters. Geographical and environmental determinants of the structure and distribution of maize races and groups of races are unambiguous. It is especially clear that altitude plays an important role in racial grouping. This is illustrated by the long recognized Mexican Pyramidal (*Cónico*) group from the central highlands and the Mexican Narrow Ear complex at or below 1800 m a.s.l. (Anderson and Cutler, 1942; Benz, 1986) and by weak differentiation among races from the highlands of southern Mexico and Guatemala (Bretting et al., 1990).

The strength of environment in determining racial distribution of maize is so large that a human role in maize evolution and distribution has been difficult to identify or weigh. Indeed, some maize researchers would dismiss a significant human role; as reflected in Wellhausen et al.'s (1957) observation that there is little evidence to define a human contribution to maize evolution. Nevertheless, research in ethnobotany and cultural ecology have begun to elucidate a role of social factors in shaping maize evolution, for instance in explaining the existence of sympatric races in single farming systems. Two lines of research have contributed here. One line is the general ethnobotany of maize, especially the work Hernández (1985) and his students (e.g. Ortega-Paczka, 1973). The second line is the cultural ecology of maize selection and management (e.g., Bellon and Brush, 1994; Louette et al., 1997). Review of these case studies reveals several common features of management: