Economic Stratification Differentiates Home Gardens in the Maya Village of Pomuch, Mexico[1]

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Economic Stratification Differentiates Home Gardens in the Maya Village of Pomuch, Mexico. In this paper, we analyze if economic stratification of peasant families in a Maya village in the Yucatán Peninsula of Mexico influences species composition and structure of home gardens. Our general hypothesis was that composition and structure reflect a higher dependence on home garden produce of relatively poorer families as compared to more prosperous families. We registered the cultivated trees and herbs in samples of twelve home gardens of poorer and wealthier families that had similar assets in the 1980s, and classified them by principal use and geographic origin. Total species richness of cultivated herbs was highest in home gardens of the more prosperous families, whereas total species richness of trees was highest in home gardens of the poorer families. Average species richness of trees and herbs and species composition was similar in both economic strata. Poorer families cultivated relatively more trees for uses other than fruit than richer families. The average and total number of native tree species and density of trees with diameter at breast height of less than 10 cm was significantly higher in poorer families' home gardens than in those of wealthier families. We conclude that economic stratification leads to different production strategies in home gardens. Richer families are comparatively more interested in obtaining fruit occasionally and emphasize diversity of herbaceous ornamentals. Poorer families emphasize different uses, favor the native flora, and increase tree density. Thereby they contribute more to biodiversity conservation than wealthier families.

Estratificación económica diferencia huertos familiares en el poblado Maya de Pomuch, México. Se analiza si la estratificación económica de familias campesinas en un pueblo Maya en la Península de Yucatán, México, influye en la composición y estructura de huertos familiares. Nuestra hipótesis general era que composición y estructura reflejan una dependencia mayor de familias relativamente más pobres de la producción de sus huertos en comparación con familias más prósperas. Registramos los árboles y hierbas cultivadas en muestras de 12 huertos de familias pobres y ricas, quienes tenían capitales similares en los años ochenta, y los clasificamos de acuerdo a su uso principal y origen geográfico. La riqueza total de hierbas cultivadas fue mayor en los huertos de familias más prósperas, mientras que la riqueza total de especies de árboles fue mayor en los huertos de familias más pobres. La riqueza promedia de especies de árboles y hierbas y la composición específica fue similar en ambos estratos económicos. Familias más pobres cultivaban relativamente más árboles para usos distintos a frutas que familias más ricas. El número promedio y total de especies arbóreas nativas y la densidad de árboles de diámetros a la altura del pecho <10 cm fue

[1] Received 25 August 2011; accepted 8 July 2012; published online 8 August 2012.

Economic Botany, 66(3), 2012, pp. 264–275

significativamente mayor en los huertos de familias más pobres que en los huertos de familias más prósperas. Se concluye que la estratificación económica conduce a distintas estrategias de producción en los huertos familiares. Familias ricas se interesan comparativamente más en obtener frutas ocasionalmente y enfatizan la diversidad de especies ornamentales herbáceas. Familias pobres enfatizan usos distintos, favorecen la flora nativa, e incrementan la densidad de árboles. Por ello contribuyen más a la conservación de biodiversidad que familias más prósperas.

Key Words: Economic stratification, species composition, native species, structure.

Introduction

Home gardens are patches of cultivated land around homesteads (Soemarwoto and Conway 1991). They have a diverse species composition and structure (Kumar and Nair 2004). Regional populations of home gardens may have a total richness of a few hundred species, whereas individual home gardens usually have above 20 species. Though a managed system with a species composition that strongly differs from forests, home gardens are often structurally similar to forests, as they show an apparently random horizontal distribution of multiple species and vertical layering in dense communities (Torquebiau 1992).

Biodiversity in home gardens includes planned and associated diversity (Vandermeer et al. 1998). Planned diversity includes deliberately planted or tolerated species, whereas associated diversity includes species that arrive spontaneously. Studies of home gardens have concentrated on planned diversity, whereas associated diversity is less often addressed (Scales and Marsden 2008). There is a particular need to study diversity in home garden mosaics—the conglomerates of individual home gardens—and its interplay with the surrounding landscape (Goddard et al. 2009; Sutherland et al. 2006). Knowledge of the factors that generate variations of planned and associated diversity in home gardens may be useful in terms of understanding their role in conservation.

Several factors influence home garden characteristics. In mountain regions, climate contributes to high diversity at intermediate altitudes, where species of both temperate and tropical zones thrive (Kehlenbeck et al. 2007). Water availability particularly generates variation in semi–arid climates (Blanckaert et al. 2004). Cultural background and market orientation influence species composition (Kehlenbeck et al. 2007), whereas family structure is associated with the structure of home gardens (Buchman 2009). Families' preferences, economic opportunities, and available space generate a wide variation in home garden species composition even within single villages (Kimber 2004; Padoch and de Jong 1991). Home garden size explains part of the variation in species richness (Van der Wal and Bongers 2012). Urbanization and short distances to markets tend to increase the number of ornamental species and commercial crops (Kehlenbeck et al. 2007; Rico-Gray et al. 1990). As several factors may operate simultaneously, their impacts on home garden features may be difficult to separate.

Economic conditions of families also contribute to variations in structure and composition among home gardens. Poorer families' home gardens in Pomuch, Mexico, had many small and young patches of woody vegetation, whereas large and old vegetation patches only occurred in home gardens of more prosperous farmers (Poot-Pool et al. 2008). In Thailand, poorer families included native species of the forest in their home gardens (Moreno-Black et al. 1996). In Hunan, China, higher incomes were associated with higher species diversity (Yongneng et al. 2006). In Indonesia, better–off families cultivated more ornamental species than poorer families, which concentrated on food species (Kehlenbeck 2007). This also seemed to be the case in Yucatán, Mexico (Herrera-Castro et al. 1993). Poorer families' home gardens in Bangladesh had lower species diversity than wealthier families' home gardens, because they were smaller (Das and Das 2005). Poorer families in Nicaragua depended more on home gardens for survival, and therefore had more diverse home gardens than richer families (Mendez et al. 2001). The foregoing shows that the influence of families' economic conditions on home gardens varies among regions.

We present results of a case study on economic stratification among farmers following the Green

Revolution modernization wave of the 1980s. We hypothesize that economic stratification is associated with differentiation of species composition and structure of home gardens. First we assess the economic conditions of relatively richer and poorer—hereafter simply "rich" and "poor"—peasant families in a Maya community in Mexico's Yucatán Peninsula, both of which had similar assets of cropland and used similar technology at the start of modernization schemes in the 1980s, but are now distinct in both aspects (Pat-Fernández 1999). We then determine and compare the species richness and composition, the structure of the cultivated flora, the distribution of plants over use categories, and the biogeographic origin of cultivated species in home gardens of both economic strata. We hypothesize that poor families' home gardens are more species rich, contain more species that are native, provide a wider range of products, contain fewer ornamental species, and have a higher tree density than rich families' home gardens. We briefly discuss implications of our findings for regional conservation of planned and associated biodiversity.

Methods

Study Area

We conducted the study in the Maya village of Pomuch in Mexico's southeastern state of Campeche. The population of Pomuch is near 8,180 habitants (INEGI 2005). Agricultural lands are held as an *ejido*, that is, a collective form of land tenure and organization that allows usufruct rights to registered members (*ejidatarios*) (Assies 2008). In 2006, there were 1,160 *ejidatarios*, of whom 500 practiced agriculture—mainly annual cropping of maize (*Zea mays* L.)—as their principal economic activity (*ejido* archives, consulted in 2010). Home gardens are privately owned.

Average yearly rainfall in Pomuch is 1,050 mm (Balam Kú et al. 1999) and is concentrated in the rainy season from June to November. Average annual temperature is 26.9° C. Soils in home gardens are shallow and rest on unconsolidated caliche parent material (Lugo-Hubp and García-Arizaga 1999). Natural vegetation in the village and neighboring lands is deciduous and of low stature (Durán-García et al. 1999). Species diversity in the regional context is high, due to the persistence of tracts of different vegetation types and accentuated by the agroforests that have resulted from traditional Maya agriculture (Toledo et al. 2008) and a high degree of endemism (Ibarra-Manríquez 1996).

Home Garden Selection

We used available information on agricultural practices of a random sample of 54 *ejidatarios* (Haas-Tzuc and Poot-Pool 2006). All had turned away from shifting cultivation to mechanized agriculture of maize monocultures on equal tracts of land during the modernization wave in the 1980s, but access to land and farming practices differentiated thereafter (Pat-Fernández 1999). Poor farmers reduced their cultivated area, replaced monocultures by mixed crops and substituted expensive mechanized activities of sowing, weeding, fertilization, and harvesting by family labor. Rich farmers widened their access to land and continued mechanized maize cropping. We selected at random 12 *ejidatarios* from each group in the original sample of 54, considering the land use system (mechanized or not) as a proxy for economic status, and studied the home gardens of each group.

Data Collection

We conducted interviews using an ad–hoc questionnaire, developed on the basis of the authors' knowledge of the local economy, to determine physical, financial, social, human, and natural capital among groups (Ellis 2000). For physical capital, we used constructed area and the number of rooms as proxies. We estimated financial capital by summing revenues of the distinct activities of family members, considering agricultural produce, retail selling of home garden products and other products, and income from wage labor and services, credits, and government subsidies. We also counted the number of animals families owned, distinguishing cows, pigs, and fowl. For social capital, we used the number of government programs in which families participate as a proxy. For human capital, we considered the average number of years that family members attended school, and the number of adult family members. For natural capital, we considered the cultivated area, home garden extension, and the number of cultivated fields.

We took a census of the woody vegetation in the home gardens and measured the height of trees, palms, plantains, and shrubs using a laser range finder, as well as the diameter of the trunks at breast height and two perpendicular crown diameters. We counted the number of plants of cultivated herbaceous species. We collected voucher specimens of unknown plants for their botanical identification at the Autonomous University of Yucatán. We determined the broad geographic origin of species, based on Barrera (1980), Ibarra-Manríquez (1996), Durán et al. (1998), Garcia de Miguel (2000), a specialized Yucatán flora website (CICY 2010), and The Royal Botanic Gardens Kew website. We distinguished between native species commonly found in the vegetation associations of the Yucatán Peninsula, neotropical species commonly found in the American tropics outside the Yucatán Peninsula, and species introduced from North America and other continents. We determined plant uses based on common knowledge and by asking family members in cases of doubt, distinguishing between the use of trees and herbs in home gardens and categorizing the various uses. Use categories are food (including fruit and condiments), medicine, and other non–food uses (for instance, ornamentation, fodder, wood, firewood, shade).

Data Treatment and Analysis

We analyzed differences in capital among the groups of rich and poor families, using *t*–tests if data had a normal distribution and non–parametrical Mann–Whitney *U*–tests if they did not. We used the Shapiro–Wilk statistic to test for normality.

We elaborated presence–absence and abundance matrices of trees (including shrubs, palms, and plantains) and herbaceous species that we found in the home gardens of rich and poor families. We performed Analysis of Similarity (ANOSIM) with the PAST program (Hammer et al. 2001) to determine if species composition—incidence and abundance of species—was different among both groups, with the abundance matrix of tree species present in four or more home gardens as an input. We used chi–squared tests to analyze if species had different abundances in both groups, and to analyze if the number of unique species was different among the groups.

We compared average observed species richness between the two groups, considering first all trees or herbs. As differences in richness may be due to different numbers of individuals (the more individuals, the more species are expected), we also compared species richness of trees determined by the individual–based rarefaction procedure (Gotelli and Colwell 2001). In this procedure, species richness is determined for a fixed number of randomly selected trees from each home garden. The procedure is repeated a number of times (runs) and the results are averaged. For individual–based rarefaction, we used the PAST program (Hammer et al. 2001) with 500 runs on random selections of 30 trees. We used *t*–tests to determine if home garden groups had different average observed richness of trees and herbs, and different richness calculated by the individual–based rarefaction procedure for trees.

We plotted the total observed species richness of trees, herbs, and native species of the two groups against the number of sampled home gardens, using sample–based rarefaction in the PAST program. This procedure produces smoothed curves, averaging the results of a used–defined number of runs with randomized order of the home gardens in each run. We performed *t*–tests to determine if slopes and elevation of simple linear regression curves on log–transformed data of the rarefaction curves were similar, following Zar (2010). We estimated total species richness of trees and herbs in both groups using the EstimateS program (Colwell 2006) and the Jackknife 1 estimator. This procedure takes into account that random samples of home gardens do not contain all species of the home garden population, and estimates the total species richness of this population. We tested differences in estimated richness among groups with *t*–tests as described for total observed species richness.

We performed *t*–tests or non–parametric Mann–Whitney *U*–tests to determine if species richness and number of individuals of species groups—organized by use or origin—were different among poor and rich families. We compared structural diversity among home garden groups as expressed by basal area, tree cover, tree density, and number of trees belonging to three diameter classes (< 10 cm, between 10 and 20 cm, and > 20 cm). We log–transformed data on tree density to resolve for non–normality. We performed *t*–tests to analyze differences of mentioned variables between both groups of home gardens.

Results

Capitals

The economic conditions of the families from the two strata were different, as anticipated (Table 1). Rich families had higher annual income, access to more land, and better housing. Sales of products from home gardens contributed

6.4 % of annual income among the poor, significantly more than the contribution of 0.8 % among rich families (Mann–Whitney *U*= 31, *P*=0.02). Rich families participated in more government–subsidized programs on animal husbandry, forestry, education, and local culture (dance, music, traditional medicine, etc.). Home garden area varied from 344 m^2 to 2,464 m^2, with a general average of 1,262 m^2 and was not different between the two groups (Table 1). Rich families seemed to have more access to education.

Species Richness and Composition

We recorded a total of 79 plant families and 236 species. The species list is available at: http://www.ecosur.mx/index.php?option=com_content&view=article&id=1876. Eighty–nine species were trees and shrubs (including palms and plantains), and 147 species were herbs (including three climbers and one epiphyte). The most species–rich families were Fabaceae (14 species), Solanaceae and Rutaceae (13 species each), and Asteraceae (11 species). The average species richness was 17.6 for trees and 22.1 for herbs in rich families' home gardens, and 21.1 for trees and 12.2 for herbs in poor families'. Average richness of trees and herbs was not significantly different among the two groups of home gardens (*t*=1.49, *P*=0.15 for trees; *U*=58, *P*=0.43 for herbs), nor was the sum of both components: 39.7 and 33.3 (Table 2) (*U*=68.5, *P*=0.84). Average species richness of random selections of 30 trees from all home gardens was 12.6 species in rich families' home gardens and 13.3 in poor families', and not significantly different among both groups (*t*=–0.49, *P*=0.63).

The total *observed* richness of trees was 68 species in home gardens of rich families and 74 in home gardens of poor families (Fig. 1a). This difference proved significant, as curves of the number of observed tree species against the number of sampled home gardens (Fig. 2a) had significantly different elevations (*t*=9.37, *P*= 0.00). Total observed richness of herbs was 127 species in rich families' home gardens, significantly higher than the 75 species found in poor families' home gardens (Figs. 1b and 2b) (t=27.9, *P*=0.00). Total *estimated* species richness showed similar differences. The Jackknife 1 estimator of total species richness of tree species was 95.4 in rich families' home gardens, significantly smaller than richness of 104.3 species in poor families' home gardens (*t*=2.24, *P*=0.04). The estimator's value for herbs in rich families' home gardens was 181.8 species, significantly more than richness of 116.3 species in the home gardens of poor families (*t*=7.56, *P*=0.00).

ANOSIM showed no significant difference in species composition of trees between both groups of home gardens. The *R* statistic—with possible values between 0 (complete similarity) and 1 (complete dissimilarity)—was 0.03. Abundance of some species varied among both groups. *Sabal mexicana* Mart. was more abundant in home

Table 1. Economic conditions of poor and rich farmers' families in Pomuch, Mexico[1].

Capital	Variable	Rich	Poor	Value statistic	P–value (2–sided)
Natural	Cultivated area (ha)	9.59	4.76	t=2.351	0.02
	Home garden area (m2)	1167	1358	t=0.900	0.37
	Number of cultivated fields	3.92	2.92	U=31	0.01
Physical	Number of rooms	2.5	1.75	U=41	0.05
	Constructed area (m2)	126	80.5	t=2.372	0.02
Financial	Annual income (Mexican $)	88,740	44,350	t=4.797	0.00
	% Income from sales of home garden products	0.8	6.4	U=31	0.02
	Number of cows	3.83	1.00	U=57	0.27
	Number of backyard fowl	22	21	t=0.129	0.89
	Number of pigs	1.83	0.42	U=63	0.48
Human	Years of education	10.7	6.6	U=42	0.08
	Number of adults	3.6	3.5	U=59	0.44
Social	Number of programs	2.6	1.8	U=41.5	0.06

[1] We used *t*–tests and Mann–Whitney *U*–tests. Years of education refers to the average number of years that owners' children living at home attended school. Number of programs refers to the number of governmental subsidy programs that families participate in. Values in columns "Rich" and "Poor" are average values for each group.

Table 2. SPECIES RICHNESS AND ABUNDANCE ACCORDING TO GEOGRAPHIC ORIGIN AND USE IN HOME GARDENS IN POMUCH, MEXICO[1].

	Variable	Rich	Poor	Statistic and Value	Significance (2–sided)
Trees	N species	17.6	21.1	t=1.493	0.15
	N individuals	55.0	78.2	t=1.878	0.07
	N native species	6.1	8.5	t=1.856	0.08
	N neotropical species	3.3	3.9	t=0.708	0.49
	N introduced species	8.1	8.7	t=0.613	0.55
	N food species	10.8	12.3	t=1.361	0.18
	N individuals food species	37.4	43.6	t=0.706	0.49
	N medicinal species	0.3	1.2	U=38	0.03
	N species with other uses	4.5	5.6	t=0.758	0.46
	N individuals other uses	7.3	18.3	U=33	0.02
	N non–food tree species	6.8	8.8	t=1.015	0.32
	N individuals non–food	17.6	34.6	U=33.5	0.03
	% non–food individuals	27.2	45.3	t=2.137	0.04
Herbs	N species	22.1	12.2	U=58	0.43
	N native species	1.3	0.8	U=64	0.61
	N neotropical species	11.6	6.1	U=52	0.25
	N introduced species	9.3	5.3	U=59	0.47
	N ornamental species	17.6	7.3	U=45	0.11
	N medicinal species	1.2	1.2	U=67	0.78
	N edible species	3.3	3.7	t=0.354	0.73
All	% native species	29.7	19.7	t=2.890	0.01
	N species	39.7	33.3	U=68.5	0.84

[1] Values in columns "Rich" and "Poor" are average values of both groups.

gardens of poor families (average of 4.5 plants) than in home gardens of rich families (average of 0.17 plants) (Mann–Whitney U=29.5, P=0.01). This species was present in eight of the poor families' home gardens, and in only one of the rich families' home gardens (chi–squared=8.71, P=0.01). Most cedar (*Cedrela mexicana* L.) and ramón trees (*Brosimum alicastrum* Sw.) occurred in home gardens of poor families (chi–squared= 12.98 and 11.88, P=0.01). Most *Spondias purpurea* L. trees occurred in home gardens of rich families (chi–squared=10.68, P=0.01). Both groups had similar numbers of unique tree species, i.e., species that do not occur in the other group (Fig. 1, chi–squared=1, P=0.31).

Cultivated herbaceous species exhibited low frequency and abundance. Sixty species occurred in only one home garden, and 48 of these had only one individual. ANOSIM showed similarity of species composition of herbaceous plants among both groups of home gardens (R=0.01). The summed abundance of herbaceous species

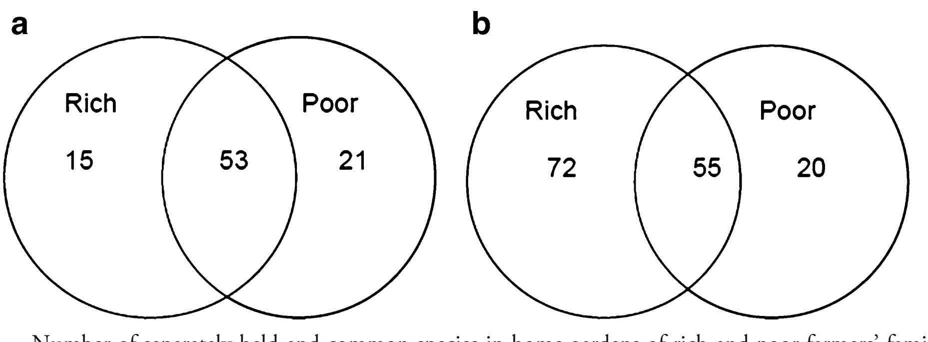

Fig. 1. Number of separately held and common species in home gardens of rich and poor farmers' families in the Maya community of Pomuch, Mexico. **a** trees, **b** herbs. Numbers refer to the total observed numbers of species in 12 home gardens of rich and poor farmers.

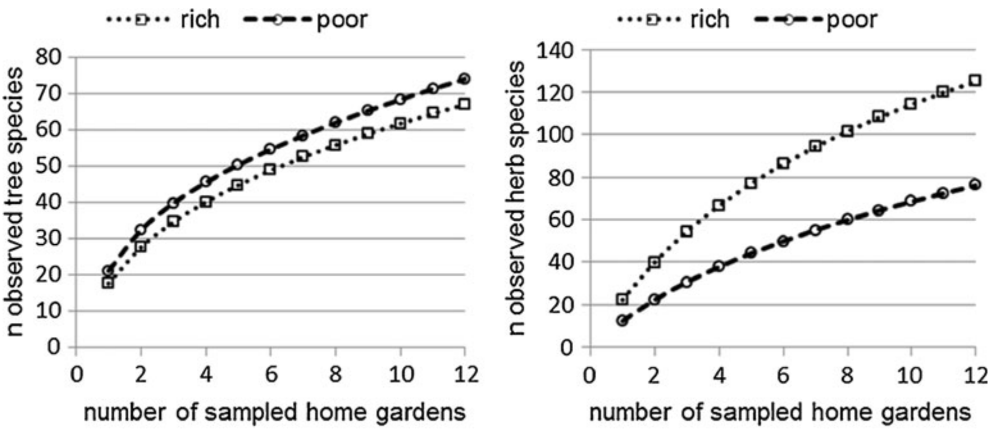

Fig. 2. Observed richness of tree species (left) and cultivated herbaceous species (right) in home gardens of rich and poor families in Pomuch, Mexico. n = number. Curves were produced by sample–based rarefaction in the PAST program (Hammer et al. 2001).

was similar in both groups (Mann–Whitney $U=65.5$, $P=0.73$). Maize was only found in two home gardens of poor families, but its incidence was not significantly different among the two groups. Rich families had 72 exclusive species, significantly more than poor families, which have only 20 (chi–squared=29.4, $P=0.00$).

Species' Origin and Uses

Of the total of 89 tree species found in the sample of 24 home gardens, 38.2 % were native of the Yucatán Peninsula, 27.0 % were of neotropical origin, and 34.8 % were introduced. Only 6.8 % of the 147 cultivated herbaceous species were native of the Yucatán Peninsula; 53.7 % were of neotropical origin, and 39.5 % were introduced.

There were on average 8.5 native tree species in home gardens of poor families, significantly more than the average of 6.1 species in rich families' home gardens (Table 2) (1–sided t–test, $P=0.04$). The total observed richness of native tree species was higher in poor families' home gardens (36 species) than in rich families' (31 species) ($t=3.18$, $P=0.00$). This was also the case for estimated total richness of native tree species, with 42 species in rich families home gardens and 49.5 in those belonging to poor families ($t=4.40$, $P=0.00$). In rich families' home gardens, on average 49.1 % of tree species were introduced, and in poor families' home gardens 41.0 %, but the difference was not significant ($U=45$, $P=0.12$). Native trees comprised 50 % of the total number of trees (individuals) in both economic strata. The average percentages of native, neotropical, and introduced herbaceous species were not significantly different among home gardens of poor and rich families (Mann–Whitney $U>66$, $P>0.70$ in all cases). The average percentage of tree and herb species (all species) that are native was significantly higher in poor families' home gardens (29.7 %) than in rich families' home gardens (19.7 %) ($t=2.890$, $P=0.01$) (Table 2). The average percentage of introduced—46.1 % for rich families' home gardens and 41.1 % for poor families'—and neotropical tree and herb species—34.3 % for rich and 29.4 for poor families' home gardens—was not significantly different among groups ($t=1.389$, $P=0.18$, and $t=1.667$, $P=0.11$).

The number of fruit tree species and its proportion of the total number of tree species was similar in home gardens of rich and poor families (Table 2). This was also the case of the other use categories, with the exception of medicinal tree species, which were more numerous in poor families' home gardens (Table 2). The average abundance of species used for fodder, shade, firewood, etc. ("other uses" in Table 2) was significantly higher in poor families' home gardens than in rich families', as was the abundance of non–fruit species (Table 2). This non–fruit category includes "other uses," as well as medicinal species and species providing wood for carpentry and construction. The average abundance of fruit species was not different between groups (Table 2). Non–fruit trees comprised 45.3 % of the total number of trees in home gardens of poor families, significantly more than the 27.2 % in home gardens of rich families ($t=2.137$, $P=0.04$).

Most of the 147 herbaceous species were ornamentals (115 species, 78.9 %). Twenty species were food and condiment species, and 8 were medicinal species. The average number of ornamental species was 17.6 in rich families' home gardens, and 7.3 in poor families', but the difference was not statistically significant (Mann–Whitney's *U*–test, $U=45$, $P=0.11$). Poor and rich families' home gardens had 37 ornamental species in common, while 65 ornamental species occurred only in rich families' home gardens, significantly more than the 13 unique species in poor families' home gardens (chi–squared = 34.7, $P=0.00$).

Structure

Average tree density (the number of trees per hectare) was 475.2 in home gardens of rich farmers and 599.0 in home gardens of poor families, but the difference was not significant ($t=1.629$, $P=0.12$, log–transformed data). The average number of trees per hectare with the diameter at breast height of <10 cm was 330.3 in home gardens of poor families, significantly larger than the 202.1 trees of this diameter class found in rich families home gardens ($t=2.036$, $P=0.05$, log–transformed data) (Fig. 3). The density of trees with diameters between 10 and 20 cm was similar in both groups (172.8 and 167.1, $t=0.346$, $P=0.73$), as was the density of trees with diameters of>20 cm (96.1 and 97.3, $t=0.06$, $P=0.96$). The basal area for both groups of home gardens was 10.0 m^2 per hectare. The fraction of basal area contributed by fruit trees was significantly larger in the home gardens of rich families than in those of poor families ($t=2.048$, $P=0.05$). Tree cover per hectare was 0.61 in poor families' home gardens and 0.72 in those of rich families, and not significantly different among both groups ($t=0.911$, $P=0.37$).

Discussion

In this study, economic stratification that has occurred since the 1980s community clearly influences the composition and structure of home gardens. This finding agrees with general observations in the literature (Caballero 1992; Herrera-Castro et al. 1993; Kehlenbeck et al. 2007; Rico-Gray et al. 1990). The present study is, however, the first to focus systematically on how economic stratification influences composition and structure. Some differences between home gardens of the relatively rich and poor strata occur on the scale of average properties of individual home gardens (Table 2, Fig. 3), and others on the scale of aggregate features (Figs. 1 and 2).

The average species richness and species composition in both groups of home gardens was not different, for neither trees, herbs, nor both taken together in the analysis (Table 2). This is because the most abundant cultivated species are the same in both groups. These are combined with other species that are not abundant and not frequent (they do not occur in many home gardens). Therefore, they have little influence in the results of the analysis of differences in species composition among the two groups. This explains why we found low *R* values (high similarity) in ANOSIM for both tree and herb species in each group. We do find differences in the number of medicinal tree species among rich and poor families' home gardens. Poor families have on average more species for medicinal uses, and more trees for non–food uses than rich families, whereas the average number of food (mainly fruit) trees is the same in both groups (Table 2). This is in general agreement with the findings of Mendez et al. (2001), who indicate that fruit trees dominate in home gardens of families who do not depend on them for income.

The observed differences in composition fit with the differences that we observed in structure, particularly tree density. Average density in poor families' home gardens was 25 % higher than in rich families' home gardens. Though this difference was not statistically significant (t–test, $P=0.12$), we did observe a significant difference in the number of trees with small diameters (< 10 cm) (*t*–test, $P=0.05$). Poor families occupy space more intensively than rich families, planting more young trees in between the older trees of the higher diameter class, which are equally abundant in both groups. Kehlenbeck et al. (2007) found higher tree density in home gardens with a market orientation. Market orientation may indeed influence the densities we found, as poor families obtained more income from selling products of their home gardens than rich families (Table 1). Beyond this, our results suggest that the more intensive use of space is a part of the multiple–use strategy that poor families practice to a higher degree than rich families, including more trees of non–fruit species in their admixtures.

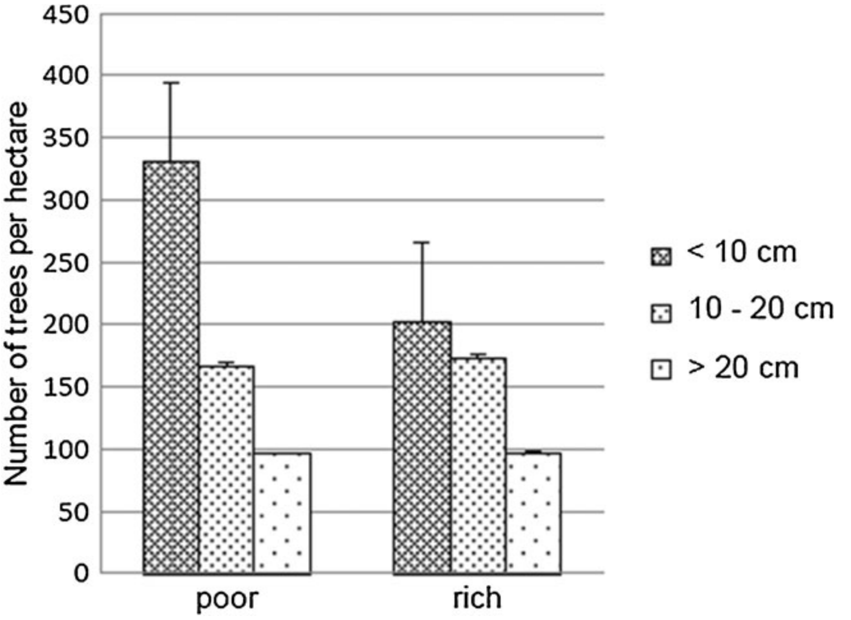

Fig. 3. Tree density in three tree diameter classes in home gardens in Pomuch, Mexico. Whiskers indicate standard errors.

Besides the aforementioned differences in average properties between home gardens of rich and poor families, we also observed differences in aggregate properties between both groups. Home gardens of poor families have more exclusive tree species—species that do not occur in the other group—than rich families' home gardens (Fig. 1), but the difference is not significant (chi–squared = 1, P= 0.31). The observed total richness of tree species was slightly higher in poor families' home gardens than in rich families', whereas observed total species richness of herbs is higher in rich families' home gardens than in poor families' (Fig. 2). Rich families have more exclusive herb species, principally ornamentals, than poor families. The number of exclusive ornamental species in rich families' home gardens was five times higher than that of poor families. High numbers of ornamental species in home gardens have been associated with a commercial strategy of owners (Mendez et al. 2001) and with a higher degree of economic well–being (Kehlenbeck et al. 2007). We find no differences in *average* species richness of ornamentals between groups (Table 2), but as a group, home gardens of rich families have a higher *total* richness of ornamentals than those of poor families. Rich families appear to focus on having ornamental species that others do not have.

We hypothesized that diversity and species composition of poor families' home gardens would reflect an economic need for a wider range of products and services than rich families' home gardens, as families adapt their selection of plants to provide the needed products and services for home consumption, cash income, exchange, and gifts through social networks (Kimber 2004; WinklerPrins and De Souza 2005). Though average richness of tree and herb species and species composition in both groups does not confirm this hypothesis, the greater abundance of non–food trees (firewood, fodder, wood, medicinal plants) in poor families' home gardens than in rich families' does. In general, individual preferences play an important role in the selection of species (Kumar and Nair 2004; Padoch and De Jong 1991; Rico-Gray et al. 1990). We therefore do not find a typical species composition in each group, but abundances of species groups that allow a more varied multiple–use strategy in poor families' home gardens than in rich families'. Native tree species for non–food uses, such as *B. alicastrum* and *S. mexicana*, are more abundant and frequent in poor families' home gardens. Related to this difference, poor families have, on average and as a group, more native tree species, in agreement with our hypothesis.

The differences between the home gardens of the two strata of farmers' families imply roles with distinct accents in regional biodiversity conservation. Poor families are prone to maintain more native species at higher abundances for fodder, medicine, fire wood, construction wood, and carpentry. With respect to associated diversity, the higher tree density in home gardens of poor families creates particular environmental conditions that may enhance the conservation of species of the regional fauna that prefer a dense vegetation cover. Conservation strategies can piggyback on this, stimulating availability of non–food tree species on the regional market. Rich families tend to concentrate on fruit trees and to introduce herbaceous ornamentals. Their interest in species of the native flora with these uses may also be enhanced by making them available on the regional market. A diversity conservation strategy along these lines would likely contribute to the conservation of planned native and associated species diversity in regional home garden mosaics (Goddard et al. 2009; Sutherland et al. 2006).

Acknowledgement

The Mexican Consejo Nacional de Ciencia y Tecnología (CONACYT) supported research through the project "Gestión y estrategias de manejo sustentable para el desarrollo regional en la cuenca hidrográfica transfronteriza Grijalva" (grant number FORDECYT–143303) and sabbatical grant number CONACYT–147619. Manuel Vargas–Domínguez and Daniel Antonio Poot-Pool helped in field work. We thank the owners of the home gardens in Pomuch, Mexico, for allowing us to do the research.

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