

# Influence of socioeconomic status on design of Batswana home gardens and associated plant diversity patterns in northern South Africa

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**Abstract** Over the last two decades, home garden studies have markedly increased in both developed and developing countries. However, garden design and its influence on the overall biodiversity of the urban green infrastructure remains a neglected aspect of home garden research. Home garden surveys were conducted in the North West and Gauteng Provinces of South Africa to contribute to this research focus. The two questions asked in this paper were: (1) Are Batswana garden designs associated with socioeconomic status (SES)? (2) Are the different garden designs characterized by specific plant species richness patterns? We hypothesized that SES influences garden design and that, as the SES of Batswana residents increases, the garden design changes from *tshimo* to colonial. Our results indicated that garden design reflected less cultural influences and took on a more Westernized colonial design appearance with improvement of SES of Batswana inhabitants. *Tshimo* gardens tended to have more native and utilitarian species. In contrast, colonial gardens have more alien ornamental species. In affluent areas, sampled Batswana gardens completely changed from a *tshimo* to colonial garden design. This change indicates that improved socioeconomic status overrides traditional cultural practices.

**Keywords** Plant diversity · Culture · Socioeconomic status · Garden design · Home garden

## Introduction

In the last two decades, gardens have captured the attention of the scientific community, and each year more studies are carried out on a broad range of subjects in this area. Garden studies in developed countries have focused mainly on biodiversity conservation and manipulation (Gaston et al. 2005; Smith et al. 2006a, b), comparisons between floristic attributes of front- and backyard gardens (Richards et al. 1984; Dorney et al. 1984; Daniels and Kirkpatrick 2006), community gardens (Corrigan 2011), and the correlation between socioeconomic factors and floristic composition (Kirkpatrick et al. 2007). In contrast, domestic garden research in developing countries has focused primarily on either ethnobotanical documentation of diversity and uses of garden species (High and Shackleton 2000; Das and Das 2005; Nemudzudzanyi et al. 2010; Molebatsi et al. 2010) or promotion of home gardening for nutritional improvement of low-income groups (Trinh et al. 2003; Wezel and Bender 2003; Blanckaert et al. 2004; Koyenikan 2007).

Garden design, however, remains a neglected aspect of domestic garden research, including its influence on the overall biodiversity of settlements. Garden experts generally distinguish between several garden styles, of which the majority are linked to specific time periods, country of origin, landscape architecture (Turner 2005), and cultural influences (Head et al. 2004). However, there are two broader categorizations that cover almost all garden styles, namely formal and informal (Van den Berg and Van Winsum-Westra 2010). Laird (1992) characterizes formal gardens by their neat and manicured look, particularly the

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regular rhythm of repeated plantings and straight lines. In contrast, informal gardens have a more natural appearance, often seeming disorganized (Kendle and Forbes 1997), while retaining a specific layout and function (Molebatsi et al. 2010).

An increasing number of studies have been done on gardens and the cultural influences that determine their species composition and layout (Head et al. 2004; Graham and Connell 2006; Nemudzudzanyi et al. 2010). The study of Mazumdar and Mazumdar (2012) found that immigrants in Southern California designed their backyard gardens to create distinctive cultural spaces, while their front yard mostly mirrored typical Southern Californian garden landscapes. In contrast, Chinese migrants settling in Melbourne, Australia prefer to maintain the existing Australian garden as is to better fit in with societal preferences (Levin 2012).

A pioneering study in Southern Africa by Nemudzudzanyi et al. (2010) also demonstrated that domestic gardens are influenced by culture, consisting of structured processes (indigenous knowledge systems) to assist with management of species with similar uses or functions. Many domestic gardens of specific ethnic groups have a distinctive layout which is repeated within and between different rural areas, reflecting the wisdom of traditional culture and ecological knowledge (Das and Das 2005; Nemudzudzanyi et al. 2010); For example, Molebatsi et al. (2010) found that the Batswana cultural group had distinctive garden designs. These Batswana *tshimo* gardens consist of microgardens that correspond to those defined for Zulu *muzi* gardens (Nemudzudzanyi et al. 2010). Additionally, socioeconomic status (SES) also influences plant diversity (Martin et al. 2004). Lubbe et al. (2010) found that the plant species richness of urban and periurban domestic gardens in South Africa was higher in more affluent areas. Hope et al. (2003) described this phenomenon as the “luxury effect.”

The studies of Lubbe et al. (2010) and Molebatsi et al. (2010) were both done in home gardens of settlements in the North West Province, South Africa. Moreover, they were inhabited by the same dominant ethnic group, the Batswana. However, the SES of these inhabitants differed widely. Moreover, Lubbe et al. (2010) included affluent non-Batswana urban gardens as well. These gardens had a typical formal appearance with lawns and ornamental species as the dominant features. These gardens were described in that paper as having colonial garden design, because of their historical colonial European descent (Ignatieva and Stewart 2009). The study of Lubbe et al. (2010) correlated SES and plant diversity but did not distinguish between different garden designs. However, Molebatsi et al. (2010) described the garden design and did not determine the SES of the residents. The aim of this study is to determine whether cultural preferences in

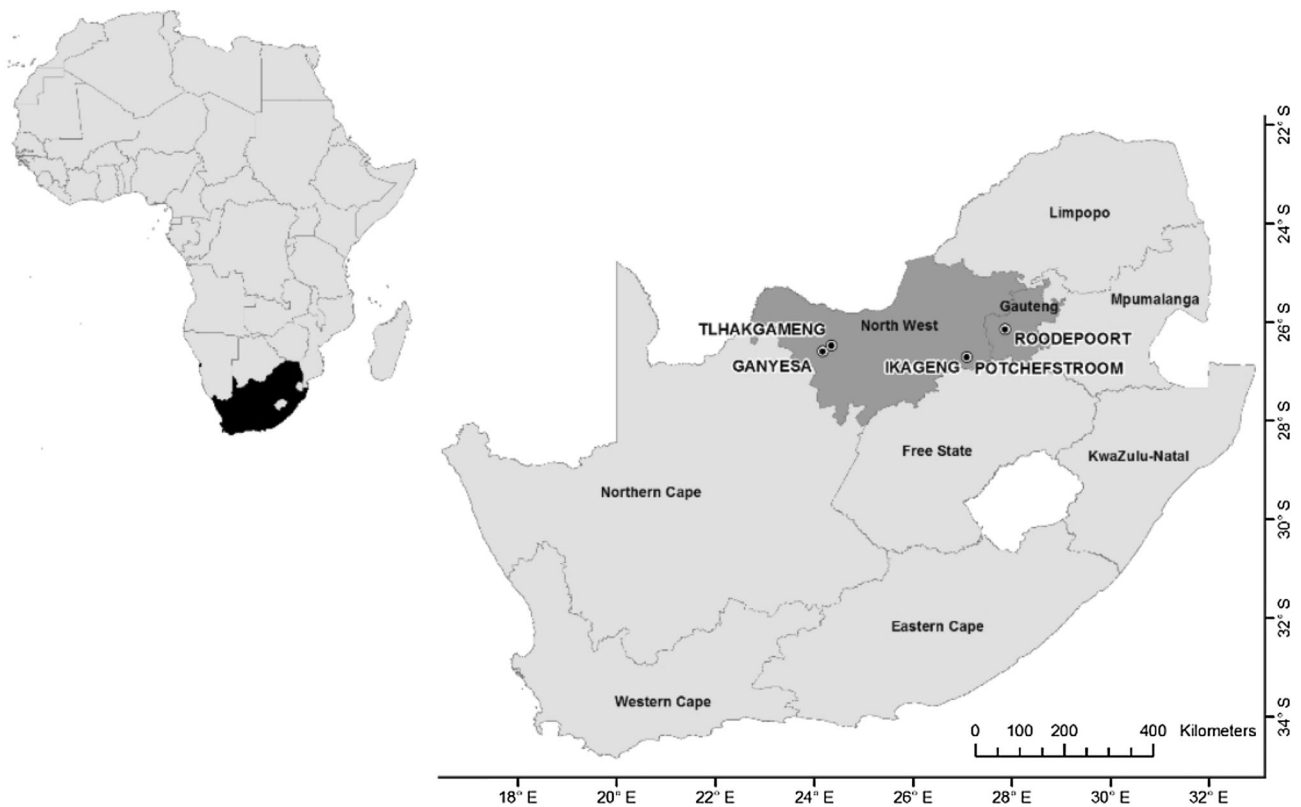
garden design of Batswana home gardens changed with improved SES. We asked two questions: (1) Are Batswana garden designs associated with SES? (2) Are the different garden designs characterized by specific plant species richness patterns? We hypothesize that SES influences garden design and that, as the SES of Batswana residents increases, the garden design changes from *tshimo* to colonial.

## Methods

### Study area

The study was conducted in the North West Province and the adjacent metropolitan area of the Gauteng Province, the economic hub of South Africa. Gauteng was included to steepen the socioeconomic gradient, as it includes more gardens of affluent citizens. In the chosen urban, rural, and metropolitan areas the dominant ethnic groups are the Batswana and people of European descent. However, numerous other ethnic groups are also found in the urban and metropolitan areas, mainly IsiNdebele, IsiXhosa, IsiZulu, Sepedi, and Indians. We limited our study to include only the two dominant ethnic groups across five study sites for comparative purposes. The study sites were selected based on source of local government management, population size, and presence of subsistence farmers (producing crops mainly for use by the farmer and his/her family, with any surplus then being sold locally for income generation) (Fig. 1):

- Metropolitan (metropolitan council management; no subsistence farmers, population greater than 1,000,000)—Roodepoort (as part of the Johannesburg Metropolitan Area) (26°07′06.8″S, 27°51′01.4″E), 50 gardens sampled
- Urban (city council management; no subsistence farmers, population greater than 100,000, but <1,000,000)—Potchefstroom (26°42′32″S, 27°05′39″E), 49 gardens sampled (Lubbe 2011)
- Periurban (city council management; <25 % subsistence farmers; population greater than 100,000, but <1,000,000)—Ikageng (a suburb of Potchefstroom) (26°43′06.2″S, 27°01′49.9″E), 39 gardens sampled (Lubbe 2011)
- Rural (municipal management; 25–75 % subsistence farmers)—Ganyesa (26°35′50″S, 24°10′32″E), 55 gardens sampled (Davoren 2009)
- Deep rural (managed by tribal authority, although under municipal authority; >75 % subsistence farmers)—Tlhakgameng (26°28′00″S, 24°21′00″E), 51 gardens sampled (Molebatsi 2011)



**Fig. 1** Location of study sites in North West and Gauteng Provinces, South Africa

**Determination of socioeconomic status (SES) classes**

Six parameters (Table 1) were used to determine the SES classes for each garden [adapted from the method of Lubbe et al. (2010)]. The parameter values of the periurban, urban, and metropolitan areas were calculated from data obtained from the 2001 National Census Survey (Municipal Demarcation Board 2006). However, the census data for the deep rural and rural areas were unreliable, so

questionnaires were used to collect the required data in those areas (Davoren 2009; Molebatsi 2011). The census data for each of the settlements are given in terms of election wards. Election wards are local municipal delineations of a subset of housing suburbs grouped together for municipal and national political election purposes (Municipal Demarcation Board 2006). A higher percentage value indicates lower SES for all the parameters (as described in Lubbe et al. 2010). To determine the SES of

**Table 1** Parameters applied to determine socioeconomic status classes of garden owners (Lubbe et al. 2010)

SES class	Number of participants	Unemployment <sup>a</sup>	Household size <sup>b</sup>	Number of rooms <sup>c</sup>	Access to basic services <sup>d</sup>	Schooling status <sup>e</sup>	Mean monthly income <sup>f</sup>
1	99	53 ± 2	37 ± 7	42 ± 7	27 ± 14	44 ± 8	82.05 ± 191
2	34	51 ± 3	35 ± 5	48 ± 7	11 ± 11	18 ± 1	108.25 ± 41
3	24	47 ± 6	38 ± 4	25 ± 7	1 ± 1	8 ± 3	117.13 ± 95
4	19	14 ± 8	16 ± 3	26 ± 5	6 ± 4	16 ± 12	292.27 ± 1212
5	80	7 ± 2	13 ± 3	14 ± 5	3 ± 2	2 ± 1	685.55 ± 2411

<sup>a</sup> % Unemployed household members

<sup>b</sup> % Households with five or more persons

<sup>c</sup> % Households with one or two rooms only

<sup>d</sup> % Households with piped water >200 m away

<sup>e</sup> % Individuals with no schooling per household

<sup>f</sup> Mean monthly income (USD 1/10.04 ZAR, exchange rate on 16 August 2013)

each garden, they were grouped according to the wards in which they were located. Principal component analysis (PCA) was performed to classify the wards into the different socioeconomic status groups using the six parameters. The wards were delineated into five SES classes based on the sorted eigenvalues of factor 1 (Supplementary Table 1). The PCA was done using STATISTICA 9.0 (Statsoft 2009).

### Floristic sampling

For the purpose of this study, a domestic garden in the South African context was defined as the area surrounding a house including all cultivated and noncultivated areas within a border that was actively tended by the inhabitants. The domestic garden surveys for Ganyesa were conducted in 2008 (Davoren 2009), with Tlhakgameng (Molebatsi 2011), Ikageng, and Potchefstroom (Lubbe 2011) in 2009, and Roodepoort (suburb of Johannesburg) in 2011. Topographic maps of each of the five study sites were acquired and overlaid with 500 m × 500 m grids in ArcView 9 (Environmental System Research Institute, ESRI 2006). This approach provided 75–141 potential sample points per study site depending on the size of the settlement. Approximately 50 sample points were randomly chosen within the grid for garden surveys per settlement. In Tlhakgameng, 51 of 118 potential sample points were sampled, in Ganyesa 55 of 141, in Ikageng 39 of 76, in Potchefstroom 49 of 75, and in Roodepoort 50 of 135. Sample points were located using the Global Positioning System. The closest garden within a 150 m radius of each random grid point was chosen. In cases where access to the chosen site was denied, an adjacent garden was sampled. The garden data from the different settled areas were consolidated into one large dataset consisting of 244 domestic gardens with approximately 600 species.

The sampled gardens differed in size. Therefore, five transects of 20 m each were placed in each garden to sample the areas that were representative of the microgardens present in each garden (microgardens are described later in the “Microgardens” section). In each transect, the nearest tree, shrub, grass, and herbaceous (nongrassy) species was noted and identified at 1 m intervals along the tape measure (20 points = 20 m). At each 1 m interval, individuals directly underneath or adjacent to the tape measure were recorded. If no individual was in the vicinity of the tape measure, the nearest individual within a block measuring 0.5 m forwards and backwards and 2 m left and right of the tape was recorded. However, if no individual was found in this block, the sampling point was recorded as bare ground. Species further than 2 m on either side of the tape measure were ignored. For trees to be recorded, the

trunk of the tree had to be within the 2 m radius from the tape measure. No individuals were counted more than once. The total sample, therefore, represented a 100-point frequency survey (20 × 5 = 100 points, total area of 400 m<sup>2</sup>). Plant species were classified according to their uses (food, medicinal, and ornamental), growth form (grass, herbaceous, shrub, and tree), and origin. The origins of the species were classified following Lubbe et al. (2010):

- *Indigenous-cultivated* occurring naturally in South Africa but not found naturally within the study area, cultivated in gardens.
- *Native* occurring naturally in South Africa and occurring naturally within the study area, usually not cultivated.
- *Naturalized* not native to South Africa, but occurring in the study area, where it sustains self-replacing populations outside of cultivation without direct intervention by people [includes declared invasive alien species according to South African legislation (CARA, Act 43 of 1983)].
- *Alien-cultivated* not native to South Africa and not naturalized in the study area, but cultivated in gardens and including garden hybrid species.

### Garden design

The study of Molebatsi et al. (2010) found that home gardens of the Batswana people in deep rural (Tlhakgameng) and rural areas (Ganyesa) had a particular garden layout called *tshimo*. *Tshimo* gardens (Fig. 2a, b) of the Batswana people are regarded as a model of resource management and indigenous knowledge (Molebatsi et al. 2010). *Tshimo* gardens are informal and are defined as a land-use form on private or communal lands, surrounding an individual house with a definite fence as border, consisting of the following dominant microgardens: food gardens, medicinal gardens, ornamental gardens, structural species, open areas (*lebala*), and natural areas (*naga*) (Molebatsi et al. 2010). Lubbe et al. (2010) found that affluent inhabitants of European descent in an urban settlement (Potchefstroom) followed a predominantly European garden design style (Ignatieva and Stewart 2009). These European-style gardens we describe as colonial gardens. Colonial gardens (Fig. 2c, d) are formal and are characterized by a large number of alien species and the presence of lawns, flowerbeds, and tree and shrub groups (Ignatieva and Stewart 2009). The different garden designs were determined for each garden using the presence/absence and dominance of microgardens.

**Fig. 2** Typical *tshimo* (a, b) and colonial (c, d) garden designs. Picture a shows a large area devoid of vegetation (*lebala*) and picture b a vegetable microgarden. Pictures c and d indicate lawns and ornamental as the main components of colonial gardens



### Microgardens

To determine whether garden design changes with increases in socioeconomic status, the following different microgardens in each home garden were recorded (based on Molebatsi et al. 2010; Davoren 2009): ornamental, vegetable, lawn, orchard, open space containing mostly native species (called *naga* in Batswana vernacular), and managed areas devoid of plants (*lebala* concept, derived from Batswana vernacular) (Fig. 2a, b). Scores were allocated to each of the microgardens based on their presence or absence and the proportion of the garden occupied (0, 1 = <33 %, 2 = 34–67 %, 3 = >67 %); For example, if a vegetable garden was present and covered 80 % of the garden it would be given a score of 3. Absent microgarden types were given a score of zero. All gardens were classified based on their scores for the different microgardens. A garden was considered to have a *tshimo* design if *lebala* and *naga* were dominant (Molebatsi et al. 2010) and colonial if lawns and ornamental microgardens were dominant (Ignatieva and Stewart 2009).

### Data analysis

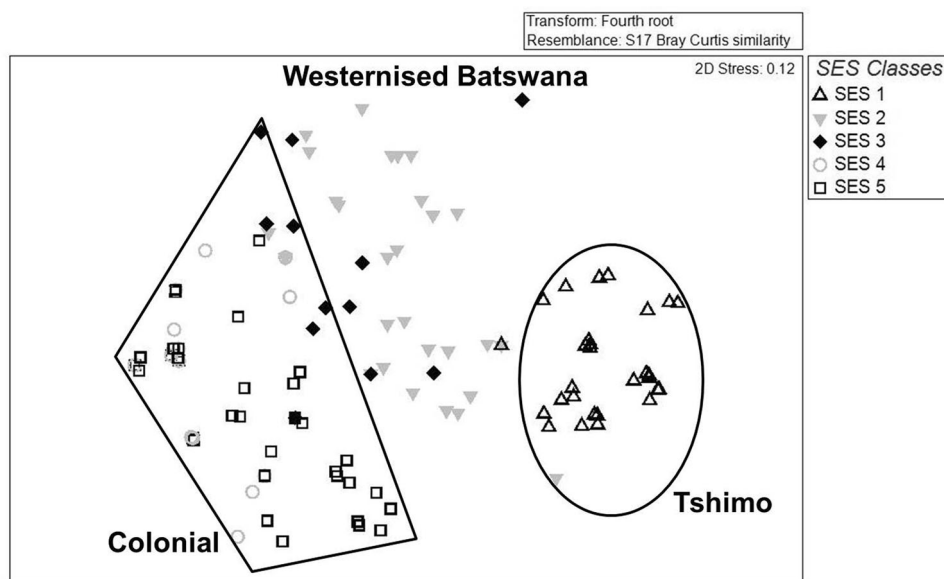
Nonmetric multidimensional scaling (NMS) was performed with Primer 6 (Clarke and Gorley 2006) to determine the relationship between socioeconomic status and garden design based on the presence/absence and

dominance of the different microgardens. The scores for each of the microgardens per home garden were converted to a similarity matrix using the Bray–Curtis dissimilarity index with fourth-root transformation as input for the NMS (Clarke and Gorley 2006).

Spearman's rank correlation coefficient ( $r_s$ ) was calculated to determine relationships between garden design, SES class, and plant origin, growth form, and uses. Spearman's was derived from the Pearson correlation coefficient after the two variables had been separately transformed to ranks but the pairing was retained after ranking (Quinn and Keough 2002).

Analysis of variance (ANOVA) was carried out to determine whether any significant differences existed between the means of two or more samples (Tabachnick Tabachnick and Fidell 2001). The ANOVA tested for significant differences between garden design, mean total number of species, mean number of indigenous-cultivated, mean number of native, mean number of alien-cultivated, mean number of naturalized, mean number of trees, shrubs, herbaceous, grass, food, medicinal, and ornamental species. Thereafter, Tukey's honestly significant difference (HSD) post hoc test for unequal sample size was carried out. This test pairwise compares the sample mean with that of every other sample to determine which samples were significantly different from others (Quinn and Keough 2002). All statistical analyses were performed with STATISTICA 9.0 (Statsoft 2009).

**Fig. 3** NMS ordination of domestic gardens grouped according to SES classes. The garden design type is indicated by the polygons



## Results

### Garden design and socioeconomic status

The NMS ordination divided the 244 domestic gardens along a clear SES gradient (Fig. 3) based on the frequency of occurrence of the microgardens in each garden. Typical *tshimo* and colonial gardens were clearly separated on the ordination (Fig. 3). These ordination groupings are in accordance with the different types of design style documented in two previous studies (Molebatsi et al. 2010; Lubbe et al. 2010). However, the gardens of SES classes 2 and 3 were grouped in between the two garden designs, indicating a transition from *tshimo* to colonial as the SES of the residents improved. We described these transitional gardens as Westernized Batswana gardens. Participants of SES class 1 predominantly followed the *tshimo* garden design, while classes 4 and 5 and several participants of class 3 (Batswana and all Europeans) followed the colonial garden design (Fig. 3). The link between garden design and

SES is further substantiated by the results of the Spearman rank correlation analyses, which indicated a positive correlation between SES and garden design (0.92), with values significant at  $p < 0.05$  (Table 3).

The most frequently occurring microgardens in the *tshimo* garden design were *lebala* and *naga* (Table 2). *Lebala* was present in all the *tshimo* gardens and covered on average 35 % of the garden (Table 2). *Naga* was present in 94 % of the *tshimo* gardens and covered on average 24 % of the garden (Table 2). In colonial gardens, on average, 43 % of the garden was covered by lawn, which was present in all of the colonial gardens. Furthermore, ornamental was present in 99 % of all the colonial gardens, covering on average 45 % (Table 2). The Westernized Batswana garden design on average consisted of 32 % lawn and 40 % *lebala* (Table 2). *Lebala* was present in all of the Westernized Batswana gardens, and lawn in 98 % of these gardens (Table 2). More than 60 % of all *tshimo* and Westernized Batswana gardens contained ornamental, which on average covered less than 14 % of the garden

**Table 2** Percentage occurrence and average percentage area of each microgarden in the different garden design types

Microgarden	<i>Tshimo</i>		Westernized Batswana		Colonial	
	Occurrence (%)	Average area (%)	Occurrence (%)	Average area (%)	Occurrence (%)	Average area (%)
Orchard	72.45	12.46	40	7.44	47.17	8.13
Vegetable	87.76	16.89	27.5	5.58	10.38	1.79
Lawn	2.04	0.33	97.5	31.63	100	43.25
Ornamental	69.39	11.31	65	13.02	99.06	45.04
<i>Lebala</i>	100	34.92	100	40	8.49	1.79
<i>Naga</i>	93.88	24.10	12.5	2.33	0	0
Total number of participants	98		40		106	

**Table 3** Spearman rank order correlations ( $r_s$ ) between socioeconomic status, garden design, and plant origin, growth form, and uses

	Garden design	SES
SES	<b>0.923970</b>	
Total no. of sp.	0.133771	0.218367
Native	<b>-0.570680</b>	<b>-0.578223</b>
Indigenous-cultivated	<b>0.397784</b>	<b>0.567408</b>
Alien-cultivated	<b>0.506280</b>	<b>0.543654</b>
Naturalized	0.005971	0.002113
Grass	<b>-0.532841</b>	<b>-0.557199</b>
Shrubs	<b>0.520608</b>	<b>0.570415</b>
Herbaceous	-0.095655	0.056979
Trees	<b>0.436069</b>	<b>0.384008</b>
Food	<b>-0.705038</b>	<b>-0.568578</b>
Medicinal	<b>-0.479341</b>	<b>-0.443155</b>
Ornamental	<b>0.771360</b>	<b>0.811256</b>

Correlations significant at  $p < 0.05$  are indicated in bold

(Table 2). Orchards were present in 72 % (12 % cover) of all *tshimo* gardens, and vegetables in 88 % (17 % cover) (Table 2).

**Plant diversity**

*Tshimo* gardens had the highest number of total, indigenous-cultivated, and native plant species (Fig. 4). Additionally, *tshimo* gardens had the highest number of useful species, such as food and medicinal plants (Fig. 5) and contained more grass and herbaceous species (Fig. 6) than the colonial and Westernized Batswana gardens. In

contrast, colonial gardens had the highest number of alien-cultivated and naturalized species (Fig. 4). Colonial gardens were also dominated by hardier, ornamental species (Fig. 5) and contained slightly more tree and shrub species (Fig. 6). Spearman rank analysis of these variables indicated that several were correlated with garden design and socioeconomic status (Table 3), supporting the observed patterns.

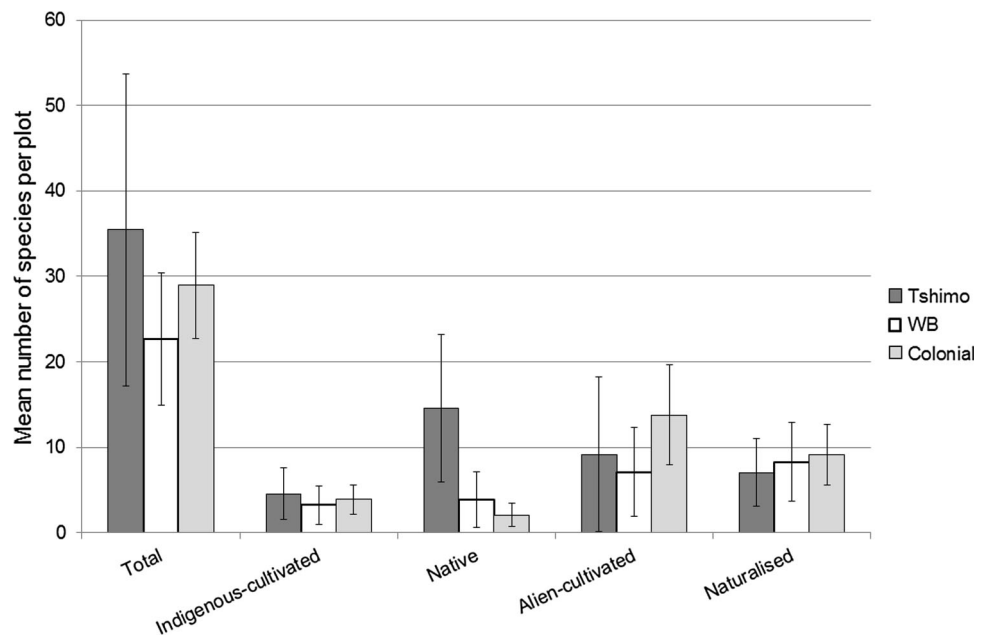
The results of the ANOVA indicated that there were significant differences between the origin, growth forms, and uses between the different garden designs (Table 4). Tukey’s HSD tests confirmed which of these designs differed significantly from one another (Table 4). Westernized Batswana (W) gardens had significantly less native species (Table 4; Fig. 4) than *tshimo* (T) gardens and significantly less alien species than colonial (C) gardens. Westernized Batswana gardens also had significantly more food plants than colonial gardens, significantly less medicinal plants than *tshimo* gardens (Table 4; Fig. 5), and significantly less trees and shrubs than both *tshimo* and colonial gardens (Fig. 6).

**Discussion**

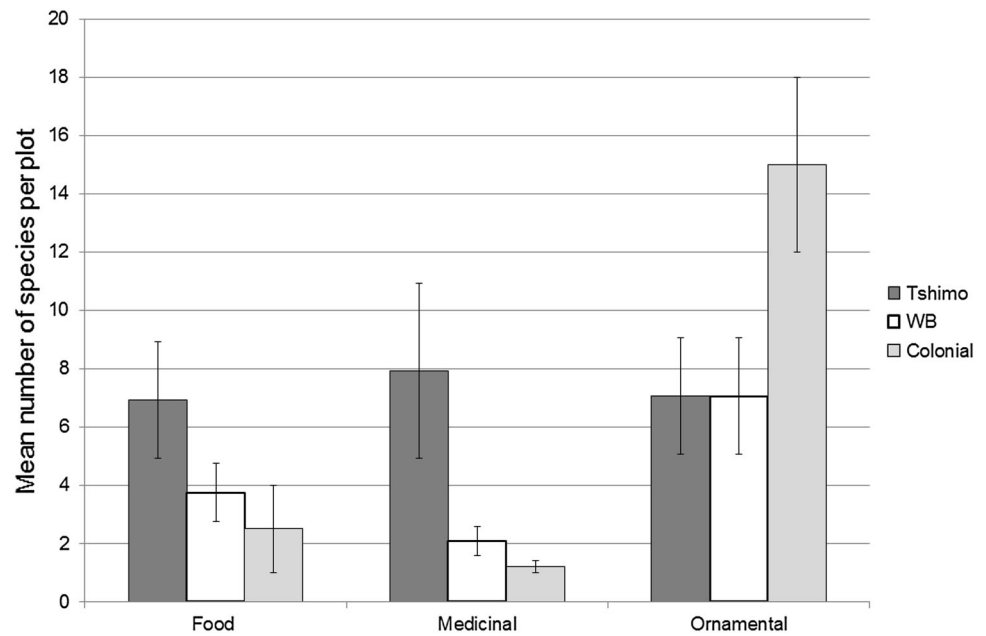
**Garden design and socioeconomic status**

Westernized Batswana gardens (Fig. 7a, b) have developed where the Western and Batswana cultures meet. These gardens exhibit both *tshimo* and colonial garden design elements (Molebatsi et al. 2010) and represent a hybrid design between formal and informal gardens (Fig. 7). The

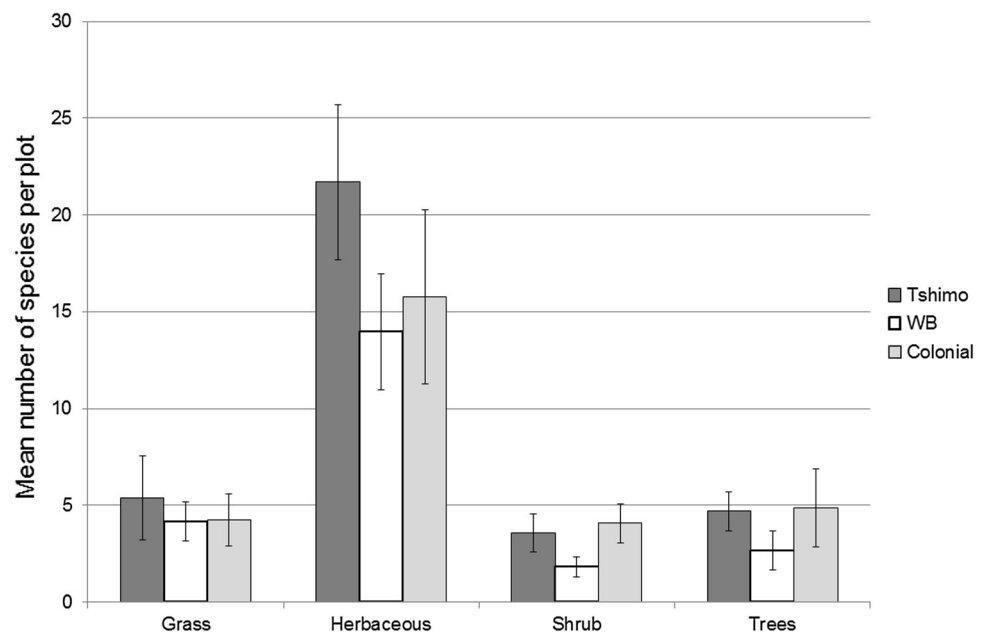
**Fig. 4** Total species richness and different origins of plant species for each garden design. Error bars indicate standard deviation



**Fig. 5** Utilitarian species for each garden design type. *Error bars indicate standard deviation*



**Fig. 6** Growth forms of each garden design type. *Error bars indicate standard deviation*



*tshimo* gardens of the Batswana were productive garden systems, while the colonial gardens of residents of European descent were more esthetically orientated with the focus on ornamental species. This finding is similar to that of Head et al. (2004), who indicated that backyard gardens of three migrant groups in Australia differed based on preference for certain species and garden uses. They stated that “particular combinations of foods results in distinctive landscapes that can be identified with particular ethnic groups” (Head et al. 2004). They found that Macedonian and Vietnamese gardens were predominately productive

gardens, in contrast to British gardens that were more floristically diverse with the focus on ornamental plants (Head et al. 2004).

Moreover, our results agree with other studies which indicated that individuals with access to resources, labor or financial means are capable of effecting change in their urban environment, whereas those individuals with limited resources are not (Martin et al. 2004; Lubbe et al. 2010). Diversity in human-created habitats has less to do with variation in the traditional limiting resources and more to do with human preferences for particular landscapes, along



**Table 4** One-way ANOVA and post hoc Tukey unequal-*N* HSD results between garden design and mean total number of species, mean number of indigenous-cultivated, mean number of native, mean number of alien-cultivated, mean number of naturalized, mean number of trees, shrubs, herbaceous, grass, food, medicinal, and ornamental species

	One-way ANOVA	Post hoc Tukey unequal- <i>N</i> HSD
Total number of species	$f_{(2,203)} = 23.5182, p = 0.000000$	T and WB, T and C
Indigenous-cultivated	$f_{(2,203)} = 6.2790, p = 0.002260$	T and WB
Native	$f_{(2,203)} = 175.2475, p = 0.00$	T and WB, T and C
Alien-cultivated	$f_{(2,203)} = 8.6696, p = 0.000244$	WB and C
Naturalized	$f_{(2,203)} = 21.9370, p = 0.000000$	T and WB, T and C
Food	$f_{(2,203)} = 21.1299, p = 0.000000$	T and C, WB and C
Medicinal	$f_{(2,203)} = 172.2131, p = 0.00$	T and WB, T and C
Ornamental	$f_{(2,203)} = 19.3335, p = 0.000000$	T and C, WB and C
Grass	$f_{(2,203)} = 8.469, p = 0.000293$	T and C
Herbaceous	$f_{(2,203)} = 22.3395, p = 0.000000$	T and WB, T and C
Shrubs	$f_{(2,203)} = 14.3807, p = 0.000001$	T and WB, WB and C
Trees	$f_{(2,203)} = 13.7591, p = 0.000002$	T and WB, WB and C

The different garden designs are indicated by *T* (*tshimo*), *WB* (Westernized Batswana), and *C* (colonial) Correlations are significant at  $p < 0.05$

**Fig. 7** Transition between *tshimo* and colonial, described as the Westernized Batswana garden design



with the availability of financial resources to realize those landscapes (Hope et al. 2003). Studies in other countries have contrasted socioeconomic status to the species richness of neighborhood vegetation (Martin et al. 2004), percentage area covered by tree canopy (Talarckek 1990), and tree presence in gardens (Kirkpatrick et al. 2007), all of which correlated positively with socioeconomic status.

### Plant diversity

The *tshimo* gardens of deep rural and rural areas contained less alien species and more native species than the colonial gardens of urban and metropolitan areas. However, the Westernized Batswana gardens of the periurban area contained more native species than the colonial gardens and less naturalized species than *tshimo* gardens. They also contained less indigenous- and alien-cultivated species than both *tshimo* and colonial gardens. Similarly, Zulu gardens in rural areas of KwaZulu-Natal had characteristically higher percentages of native species than those in periurban areas (Nemudzudzanyi et al. 2010). According to

Nemudzudzanyi et al. (2010), the residents of periurban areas are predominantly first- or second-generation residents who prefer well-known and readily available alien species over local native flora of which they possess little knowledge.

Colonial gardens contained less utilitarian species than both *tshimo* and Westernized Batswana gardens, and in turn Westernized Batswana gardens contained less utilitarian species than *tshimo* gardens. These differences validate the status of Westernized Batswana gardens as a transitional design type between *tshimo* and colonial. In contrast to gardens from Western countries, which rarely contain utilitarian plants (Kirkpatrick et al. 2007), gardens in the rural areas of developing countries contain species that are selected based on their medicinal, food or spiritual value (Blanckaert et al. 2004; Winklerprins and De Souza 2005; Jaganmohan et al. 2012).

In the current study, there were no apparent differences between the mean tree and shrub species richness of the colonial gardens and that of the *tshimo* gardens. These findings are in contrast to the study of Iverson and Cook

(2000), who found that wealthy regions of the Chicago Metropolitan Area had a higher percentage tree cover than poorer regions. In traditional *tshimo* gardens, trees and shrubs are actively planted for specific purposes, such as windbreaks, shade, as lightning deflectors, and for spiritual reasons (Molebatsi et al. 2010). This active planting might be the reason *tshimo* and colonial gardens had similar mean tree and shrub species richness despite major differences in SES. However, *tshimo* and colonial gardens had more tree and shrub species than Westernized Batswana gardens, which may be an indication of new preferences associated with the emerging African middle class and the abandonment of cultural practices. The study of Nemudzudzanyi et al. (2010) also found that indigenous knowledge systems were in danger of being lost under the impact of modernization and the ongoing globalization process. They concluded this since Zulu home gardens of periurban areas in KwaZulu-Natal also tended to follow a more Westernized landscaping approach. Moreover, Kendal et al. (2012) found that some Ballarat residents in Australia, with higher incomes, preferred to live in new housing estates with lower levels of tree cover than in areas with established housing and higher levels of tree cover.

## Conclusions

*Tshimo* gardens are models of indigenous knowledge systems (Molebatsi et al. 2010), while colonial gardens are of European origin reflecting esthetic preferences (Lubbe et al. 2010). We identified the Westernized Batswana garden as a transitional garden design between the colonial and *tshimo* designs. Colonial gardens in urban and metropolitan areas were floristically more diverse than *tshimo* gardens in rural and deep rural areas. This diversity can be ascribed to the SES of the residents of the colonial gardens that allowed financial freedom [the “luxury effect” Hope et al. (2003)] and access to water and other resources which enabled cultivation of a wide variety of species. The recognition of the Westernized Batswana design type confirmed our hypothesis that socioeconomic status overrides cultural preferences in Batswana home gardens. As Batswana residents of the periurban area gain access to resources needed to effect change in their gardens, these gardens take on a more Westernized appearance.

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