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# The diet and ecological role of giraffe (*Giraffa camelopardalis*) introduced to the Eastern Cape, South Africa

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**Abstract**

With an increase in the popularity of wildlife ranching in southern Africa has come the introduction of non-native (extralimital) mammalian herbivores. Financial gain has arguably been at the forefront of these introductions, with little or no assessment of the ecological consequences. The diet of three populations of introduced giraffe *Giraffa camelopardalis* was assessed by direct observation in the Eastern Cape Province, South Africa between January 2002 and October 2003, as the first step towards understanding the ecological role played by giraffe in the region. Similar to the diet of giraffe within their native range, a deciduous species from the genus *Acacia* (*Acacia karroo*) was the most important species in the diet. Giraffe in the Eastern Cape Province, however, consumed more evergreen species than those within their native range. The relative lack of deciduous species in the Eastern Cape Province provides a probable explanation for such a result. Seasonal variation in the consumption of the most important species in the diet was evident with members of the genus *Rhus* being more important in the winter months. This was attributed to the deciduous nature of *A. karroo*. The potential for giraffe to have a detrimental effect on the indigenous vegetation is discussed. We conclude that the study provides a much-needed list of plant species threatened by giraffe browsing in a region where the vegetation is thought to have evolved in the absence of such a browser.

**Key words**: giraffe, *Giraffa camelopardalis*, extralimital, diet, herbivore

## INTRODUCTION

The Eastern Cape Province, South Africa forms a complex transition zone between four major phytochoria, the Cape, Tongoland-pondoland, Karoo-Namib and Afromontane (Lubke, Everard & Jackson, 1986). Consequently, the region has a high diversity of plant species. This diversity once supported a vast array of mammals, many of which, especially the large carnivores, were shot-out towards the latter half of the 19th century (Skead, 1987; Boshoff & Kerley, 2001). Now, the pattern of land use in the Eastern Cape is changing rapidly from agriculture and livestock farming to wildlife ranching. While this change in land use has promoted the conservation of endangered species that were once locally extinct (e.g. cheetah *Acinonyx jubabtus*, Schreber, and wild dog *Lycaon pictus*, Temminck), many private wildlife ranching operations have introduced non-native (extralimital) mammalian herbivores because of their tourism or hunting potential (Castley, Boshoff & Kerley, 2001). The giraffe *Giraffa camelopardalis*, L. is one such species. These introductions have engendered much philosophical and ethical debate in the popular literature, prompting conservation authorities to draft legislation in an attempt to control the introductions. Charismatic species such as giraffe, however, continue to be introduced owing to their popularity amongst foreign tourists. Thus, it is clear that targeted research into the effects of giraffe introductions is required.

The diet assessment of herbivores is crucial; not only in understanding trophic relationships, but also in providing insight into potential competition with other herbivores and the influences the herbivore may have on an ecosystem (Bookhout, 1996). In addition, studies of herbivore diets are useful in that they provide the initial step towards understanding the resources and habitat required before any management efforts can be initiated (Bookhout, 1996). The diet of giraffes has been the focus of much research around Africa. Only one study, however, emanates from the Eastern Cape Province (Parker, Bernard & Colvin, 2003). This pilot study illustrated that giraffe in the Eastern Cape Province, like giraffe in their native range, prefer deciduous species such as those from the genus *Acacia* during the summer months, and switch to more evergreen species during the winter when the preferred species decrease in abundance

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(Parker *et al*., 2003), but the study was restricted to one study site for just two seasons. Thus, a more intense study of the diet of giraffe in the Eastern Cape Province was required.

In this paper, the diet of giraffe was assessed using direct observations at three sites, as the first step towards understanding the ecological importance of the species in the Eastern Cape Province. The specific aims of this study were to determine the diet of giraffe in the Eastern Cape Province; to ascertain the seasonal variation in the diet; and to compare the diet of giraffe in their native range to those introduced to the Eastern Cape Province.

## MATERIALS AND METHODS

### Study sites

The study was conducted at 3 sites in the Eastern Cape Province of South Africa. The sites were selected based on their size, geographical position, giraffe population size, and the length of time the giraffe had been present on each property. Kariega Game Reserve (hereafter referred to as Kariega) lies at 33°35′S and 26°37′E. Kwandwe Private Game Reserve (Kwandwe) is situated at 33°09′S and 26°37′E, and Shamwari Private Game Reserve (Shamwari) is positioned at 33°20′S and 26°01′E.

Kariega was the smallest of the 3 study sites being only 1900 ha and the site closest to the coast (10 km). The dominant geological formations of the reserve include Beaufort group shale, mudstone, solonetic soils and sandstone; and Cape supergroup sandy clays and lithosols (Low & Rebelo, 1996). The perennial Kariega River flows through the reserve for 11 km and is the major water source apart from several small dams. Kariega falls within the spring-dominated rainfall region of the province but has a pronounced bimodal rainfall pattern (Stone, Weaver & West, 1998). This bimodal pattern of rainfall results in Kariega having the highest rainfall of the 3 sites (∼ 700 mm) per annum (Low & Rebelo, 1996). The increased precipitation at Kariega can also be attributed to coastal fog owing to its proximity to the coast (Stone *et al*., 1998). Large variations between night and day temperatures are moderated by the reserve being closer to the coast (Stone *et al*., 1998). The vegetation of Kariega comprises coastal forest, valley thicket, eastern thorn bushveld, secondary acacia thicket and old farmlands with valley thicket the most dominant vegetation type (Low & Rebelo, 1996). Six giraffe were introduced to the reserve in 1991 and from a nucleus of 2 males and 4 females; the population had grown to 16 animals (5 males and 11 females) at the time of the study. No large predators had been introduced to the reserve, however, leopard *Panthera pardus*, L. and caracal *Felis caracal*, Schreber are known to be present. No giraffe mortalities had been recorded since their introduction.

Kwandwe is ∼16000 ha and the farthest inland site (70 km) with Ecca group shales, Cape supergroup sandy clays and lithosols, Dwyka and Ecca formations, and Beaufort group dolerites the dominant geological formations (Low & Rebelo, 1996). The perennial Great Fish River flows through the reserve for 25 km. Two large and several smaller man-made dams provide important sources of water. Kwandwe straddles both the spring and autumn-dominant rainfall regions of the province and consequently, distinct bimodal rainfall is experienced (Stone *et al*., 1998). However, rainfall at Kwandwe is only *c*. 400 mm per annum as it is situated on the leeward side of an extension of a mountain chain (Low & Rebelo, 1996). Kwandwe experiences hot summers (temperatures often exceeding 35 °C) and cool (below 5 °C) winters with widespread frost owing to radiational cooling on clear winter nights (Stone *et al*., 1998). The vegetation of Kwandwe can be divided into 7 major vegetation types: medium portulacaria thicket/xeric succulent thicket, short euphorbia thicket, tall euphorbia thicket, riverine thicket, bushclump karoo thicket, bushclump savanna and karoo shrubland/eastern mixed nama karoo (Low & Rebelo, 1996). Bushclump savanna and medium portulacaria thicket are the 2 dominant vegetation types on the reserve. Thirty giraffe (12 males and 18 females) were introduced to the reserve in 2001. This population had grown to 34 by 2003 with 5 calves born and 2 deaths. One death was the result of stress during translocation, and 1 was believed to have been due to extreme cold. Large predators on the reserve include lion *Panthera leo*, L., leopard, cheetah and brown hyena *Hyena brunnea*, Thunberg.

Shamwari was the largest site (∼ 20000 ha), traversing 4 geological formations (i.e. Bokkeveld series shale; Witteberg quartzites; Karoo sandstone and Sundays River formations), and is 40 km from the coast. The semi-perennial Bushmans River is the major water source, flowing through the reserve for 27.6 km. Numerous small dams and pans, dotted throughout the reserve, are the other important water sources. Shamwari is situated in the spring dominant rainfall region of the province and receives *c*. 550 mm of rainfall per annum (Low & Rebelo, 1996; Stone *et al*., 1998). However, bimodal rainfall is experienced during the autumn and spring months (O'Brien, 2000). Shamwari's locality means that the climate of the reserve is intermediate compared to the other 2 sites. There are 13 vegetation types represented on the reserve (Low & Rebelo, 1996), and the subtropical thicket/valley thicket, bushclump savanna and *Acacia karroo* thickets dominate (O'Brien, 2000). Giraffe (numbers unknown) were introduced in 1993 and 1994. The current population (2003) stands at 18 individuals with an equal sex ratio. The large predators on the reserve include lion, leopard, cheetah, brown hyena and wild dog. One calf and 1 adult female giraffe have been killed by lion since their introduction.

### Direct observations

Direct observations of the diet of the giraffe at each site were made using the interval scan method, making feeding records every 2 min over a period of 1 h (van Aarde &

Skinner, 1975; Tacha, Vohs & Iverson, 1985; Rose, 2000; Parker *et al*., 2003). A feeding record was defined as each instance in which 1 plant species was consumed by 1 animal during a particular scan. Therefore, if 10 giraffe were feeding on species (a) during a scan, there would have been 10 feeding records for that species for that particular scan. Six days of observations were conducted at each site for each season; autumn (March–May), winter (June–August), spring (September–November) and summer (December–February). On each day, the first group of giraffe encountered was observed so as to reduce observer bias for a particular group of giraffe or region. Three 1-h long observation sessions were undertaken each day, such that 1 h was completed during the morning (defined as 06:00–09:00), 1 h at midday (11:30–13:30) and 1 h in the afternoon (15:00–18:00). For each 6-day session (i.e. each season's data) there were thus 18 h of observation, 6 in the morning, 6 at midday and 6 in the afternoon. Feeding records for the plant species consumed, the time of day, number of animals, habitat type, other behaviour and weather conditions were recorded. Samples of plant species that could not be positively identified in the field were taken to the Selmar Schönland Herbarium in Grahamstown for identification. The feeding records for each species consumed during 1 h were totalled and expressed as a percentage of all feeding records for that hour (i.e. frequency of occurrence). The plant species that displayed a frequency of occurrence of $> 20\%$ on any 1 day on which observations were conducted were recognized as the most important species at each site.

### Data analysis

Differences in the frequency of occurrence of the most important species in the diet between the 3 different times of the day that observations were made and between seasons were tested using a Kruskal–Wallis 2-way ANOVA median test (Sigmastat version 2; Jandel Corporation) after arcsine transformation.

## RESULTS

The direct observations revealed that giraffe at the three sites consumed 48 plant species, from 30 families over the study period 2002–03 (Table 1). These included 46 woody plant species, one shrub and one grass species (Table 1). The mango (Anacardiaceae), spike thorn (Celastraceae) and thorn-tree (Mimosaceae) families were the best represented in terms of numbers of species consumed. However, the Mimosaceae and Anacardiaceae made up the majority ($> 65\%$) of the diet in terms of frequency of occurrence (Table 1). *Acacia karroo* (43%) and *Rhus longispina* (17%) were the two most important species in the diet across all three sites and seasons (Table 1). The remaining species were all below 6% in importance. Most of the species consumed (38 or 79%) were evergreen. Two alien invasive species to South Africa (*Acacia mearnsii* and *A. cyclops*) as well as one species (*Dombeya rotundifolia*) listed as threatened in the South African Red Data book for plants were consumed by the giraffe. A very small proportion of the diet remained unidentified (Table 1). The relative importance (frequency of occurrence) of the various species in the diet at each site was not significantly different between the three

**Table 1.** The mean annual frequency of occurrence (M.A.F.O.) of plant species in the diet of giraffe *Giraffa camelopardalis* for all sites and seasons as determined by direct observations for the study period 2002–03. Values are percentages ±1 SD. Figures do not add up to 100 due to rounding off. [e] Evergreen; [d]deciduous; [s-d]semi-deciduous

| Family | Species | M.A.F.O. |
|---|---|---|
| Agavaceae | *Agave* sp. | 0.20 ± 2.99 |
| Anacardiaceae | *Harpephyllum caffrum*[e] | 0.15 ± 1.27 |
| | *Rhus crenata*[e] | 2.25 ± 7.98 |
| | *Rhus lancea*[e] | 0.02 ± 0.18 |
| | *Rhus longispina*[e] | 16.62 ± 22.48 |
| | *Rhus pallens*[e] | 2.72 ± 9.67 |
| Apocynaceae | *Carissa haematocarpa*[e] | 0.07 ± 0.75 |
| Asteraceae | *Brachylaena ilicifolia*[e] | 0.02 ± 0.32 |
| | *Tarchonanthus camphoratus*[e] | 0.90 ± 0.74 |
| Bigoniaceae | *Tecomaria capensis*[e] | 0.01 ± 0.18 |
| Boraginaceae | *Ehretia rigida*[d] | 0.11 ± 1.07 |
| Caesalpiniaceae | *Schotia afra*[e] | 3.20 ± 8.84 |
| | *Schotia latifolia*[e] | 0.81 ± 5.22 |
| Capparaceae | *Boscia oleoides*[e] | 1.15 ± 4.79 |
| | *Capparis sepiaria*[e] | 0.31 ± 1.47 |
| Celastraceae | *Cassine aethiopica*[e] | 0.27 ± 1.69 |
| | *Gymnosporia buxifolia*[e] | 0.49 ± 2.45 |
| | *Gymnosporia polyacantha*[e] | 0.85 ± 4.02 |
| | *Maytenus capitata*[e] | 0.08 ± 0.41 |
| Chenopodiaceae | *Exomis microphylla* | 0.53 ± 5.64 |
| Combretaceae | *Combretum caffrum*[d] | 0.05 ± 0.45 |
| Ebenaceae | *Diospyros dichrophylla*[e] | 0.58 ± 3.54 |
| | *Diospyros lycioides*[e] | 0.06 ± 0.36 |
| | *Euclea undulata*[e] | 5.36 ± 12.42 |
| Flacourtiaceae | *Dovyalis caffra*[e] | 0.03 ± 0.36 |
| Loganiaceae | *Buddleja saligna*[e] | 0.28 ± 1.65 |
| | *Strychnos decussata*[e] | 0.11 ± 0.8 |
| Mimosaceae | *Acacia caffra*[d] | 0.34 ± 3.24 |
| | *Acacia cyclops*[e] | 0.94 ± 6.64 |
| | *Acacia karroo*[d] | 43.27 ± 36.37 |
| | *Acacia mearnsii*[e] | 0.48 ± 2.77 |
| Oleaceae | *Olea europea*[e] | 0.62 ± 5.12 |
| Plumbaginaceae | *Plumbago auriculata*[e] | 0.11 ± 0.72 |
| Poaceae | *Panicum stapfianum* | 0.07 ± 0.74 |
| Portulacaceae | *Portulacaria afra*[e] | 1.91 ± 8.59 |
| Ptaeroxylaceae | *Ptaeroxylon obliquum*[s-d] | 0.06 ± 0.63 |
| Rhamnaceae | *Scutia myrtina*[e] | 2.03 ± 7.25 |
| Rubiaceae | *Canthium spinosum*[e] | 2.28 ± 8.61 |
| | *Coddia rudis*[e] | 0.09 ± 1.36 |
| Salicaceae | *Populus deltoides*[d] | 0.04 ± 0.46 |
| Salvadoraceae | *Azima tetracantha*[e] | 1.81 ± 4.69 |
| Santalaceae | *Osyris compressa*[e] | 0.01 ± 0.09 |
| Sapindaceae | *Pappea capensis*[e] | 3.81 ± 11.74 |
| Sapotaceae | *Sideroxylon inerme*[e] | 1.98 ± 6.86 |
| Solanaceae | *Lycium* sp.[e] | 3.11 ± 10.77 |
| Sterculiaceae | *Dombeya rotundifolia*[d] | 0.02 ± 0.23 |
| Tiliaceae | *Grewia occidentalis*[e] | 0.31 ± 2.67 |
| | *Grewia robusta*[e] | 0.18 ± 1.54 |
| | Unidentified | 0.36 ± 1.50 |
| Total | | **100.72** |

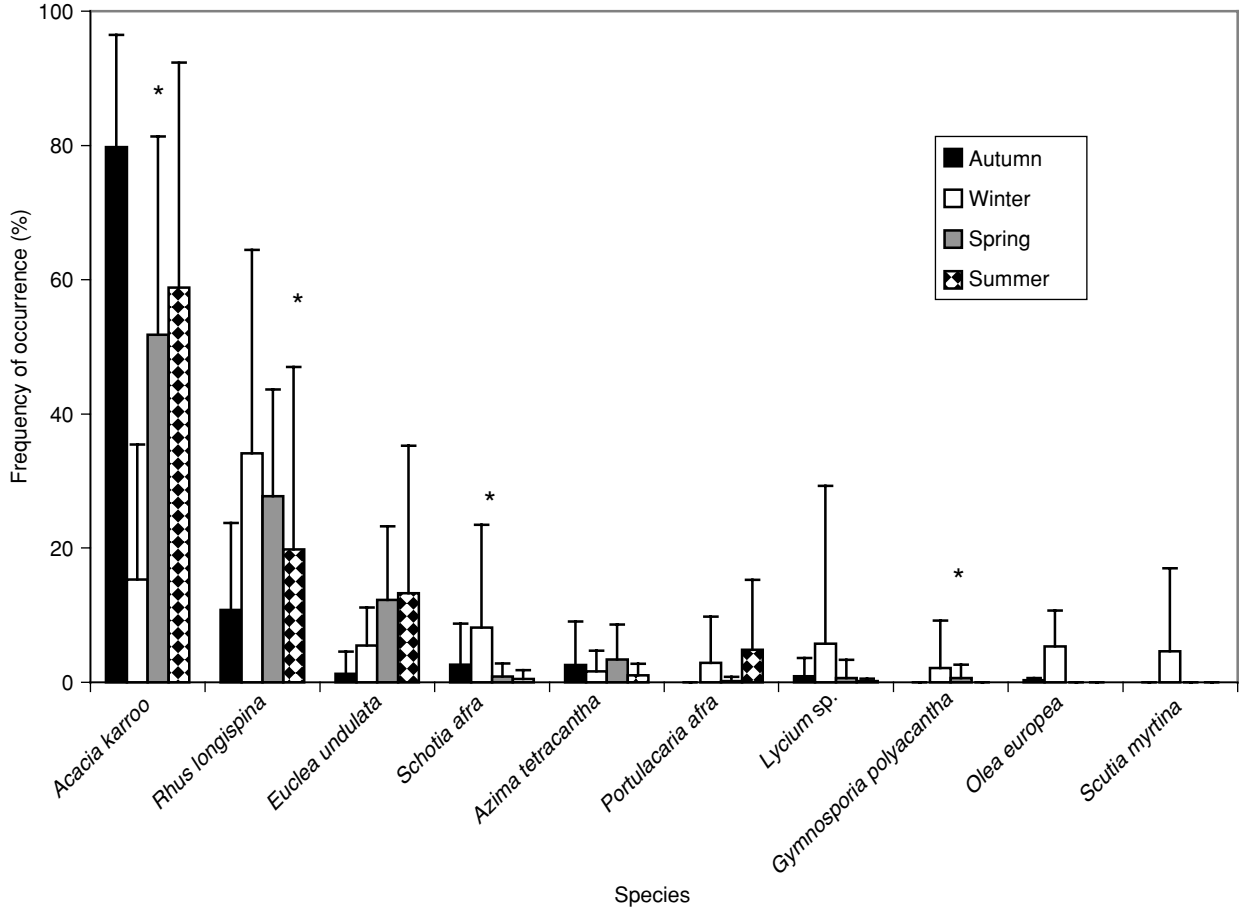


**Fig. 1.** The most important species in the diet of giraffe *Giraffa camelopardalis* at Shamwari. The mean values ± 1 SD for each season are shown. *$P < 0.05$ between seasons for a species (Kruskal–Wallis ANOVA).

different times of the day that observations were conducted (Kruskal–Wallis ANOVA; $P > 0.05$). Thus, the data for each day were combined and frequency of occurrence values calculated for each season. Only those species that exhibited a frequency of occurrence of greater than 20% on any 1 day on which observations were made were recognized as the most important species in the diet at each site.

At Shamwari 23 species were consumed, 10 were recognized as the most important, nine of which were evergreen (Fig. 1). *Acacia karroo* was the most important species in the diet during all seasons except winter, when significantly less was consumed (Fig. 1; $P < 0.05$, d.f. $= 3$, $F = 19.72$). *Rhus longispina* was the second most important species in the diet at Shamwari, with significantly more being consumed in winter than autumn (Fig. 1; $P < 0.05$, d.f. $= 3$, $F = 3.15$). *Euclea undulata* was the third most important species in the diet and was most important during the spring and summer months (Fig. 1). The importance of the other species remained low during all seasons. However, significant seasonal fluctuations were evident in *Schotia afra* ($P < 0.05$, d.f. $= 3$, $F = 3.89$) with more eaten in winter than spring and summer and *Gymnosporia polyacantha* ($P < 0.05$, d.f. $= 3$, $F = 3.82$) with more eaten in winter and spring than summer and autumn (Fig. 1).

A similar pattern to that found at Shamwari was present at Kwandwe. Twenty-two species were consumed, of which seven species constituted the most important species in the diet. Of these species, *Acacia karroo* and *A. caffra* were deciduous and the remaining five species evergreen. *Acacia karroo* was the most important species, with significantly less being consumed in the winter than summer and autumn (Fig. 2; $P < 0.05$, d.f. $= 3$, $F = 8.59$). Although not statistically significant, the importance of *R. longispina* (again the second most important species) increased in the winter months. *Pappea capensis* was the third most important species at Kwandwe with significantly more being consumed in the summer than spring (Fig. 2; $P < 0.05$, d.f. $= 3$, $F = 3.53$). The fourth most important species (*Euclea undulata*) was consumed equally throughout the year (Fig. 2). The importance of the remaining species was low, but peaks in the importance of *Portulacaria afra* ($P < 0.05$) and *Lycium* sp. ($P > 0.05$) during the autumn and winter, respectively were evident (Fig. 2).

The number of important species in the diet of the giraffe at Kariega was substantially higher (15) than the other two sites and the majority of these species (14) were evergreen (Fig. 3). The total number of species consumed at Kariega (37) was also higher than at the other reserves. *Acacia karroo* was again the most important species

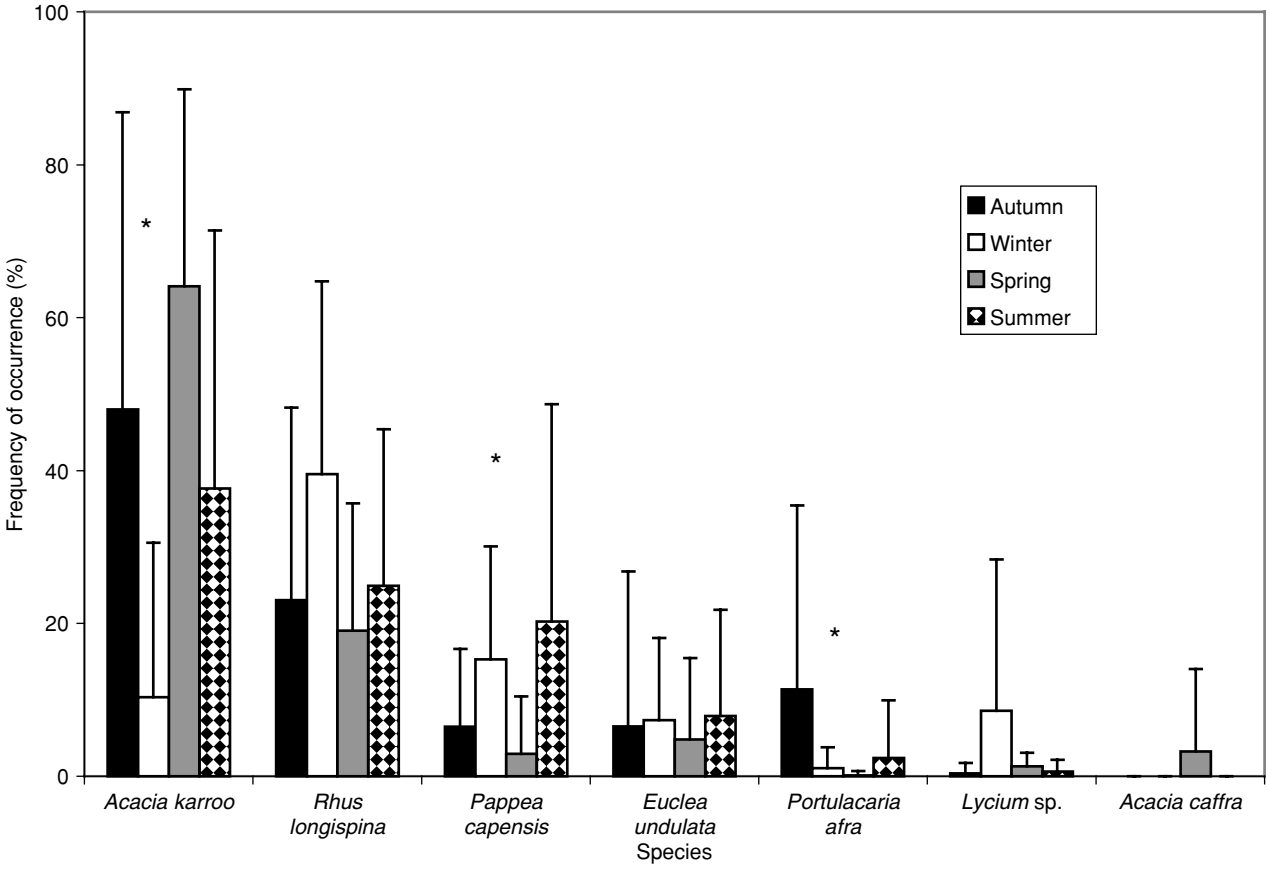


**Fig. 2.** The most important species in the diet of giraffe *Giraffa camelopardalis* at Kwandwe. The mean values ± 1 SD for each season are shown. *$P < 0.05$ between seasons for a species (Kruskal–Wallis ANOVA).

overall. Although the giraffe consumed less *A. karroo* in the winter, the reduction in use was not statistically significant as it was at the other two sites (Fig. 3). *Rhus crenata, R. pallens, Schotia afra, Canthium spinosum, Sideroxylon inerme* and *Scutia myrtina* were the other notable species in the diet at Kariega (Fig. 3). Only the frequency of occurrence of *S. afra* and *S. myrtina* changed between seasons. Significantly more *S. afra* ($P < 0.05$, d.f. = 3, $F = 3.09$) was eaten in autumn and winter than spring while *S. myrtina* was significantly ($P < 0.05$, d.f. = 3, $F = 3.86$) more important in spring than winter and autumn (Fig. 3). The alien *A. cyclops* was significantly more important in the spring than winter and summer (Fig. 3; $P < 0.05$, d.f. = 3, $F = 2.85$).

Overall, the results indicate that during the summer months the diet of giraffe in the Eastern Cape Province was dominated by *A. karroo* and *R. longispina* (Figs 1–3). During the winter *R. longispina* became more important in the diet than *A. karroo* at two of the sites and the combined importance of these two species in the winter was lower than in the summer.

## DISCUSSION

Giraffe typically select > 20 plant species in their diet (Leuthold & Leuthold, 1972; Hall-Martin, 1974; van Aarde & Skinner, 1975; Sauer, Theron & Skinner, 1977; Sauer, Skinner & Neitz, 1982). This is ascribed to the fact that giraffe are capable of traversing large distances within their home ranges where they encounter and use a wider variety of vegetation types than other browsers (Skinner & Smithers, 1990). In addition, owing to their inherent need to consume large quantities of forage to sustain their metabolic and reproductive requirements (Bell, 1971; Pellew, 1984*a*), giraffe have less time to be selective and consequently include a wide diversity of plant species in their diet (Innis, 1958). The results for the present study conform to such a finding with > 20 species being consumed at each site. However, the number of species consumed was greater at Kariega (37) than at the other two sites (22 and 23, respectively). The small size of Kariega provides a probable explanation for such a difference, as being confined into such a small area at a relatively high density (there are similar numbers of giraffe as at Shamwari, but in a smaller area) forces the animals to feed on a greater number of species. Alternatively, the giraffe at Kariega may have included a wider range of species in their diet as more species were available to them (results not shown). Kariega is dominated by valley thicket, which is one of the more diverse vegetation types in the Eastern Cape Province (Lubke e*t al*., 1986). Although the giraffe at all sites consumed a large variety of species, the majority (60–90%) of the diet comprised

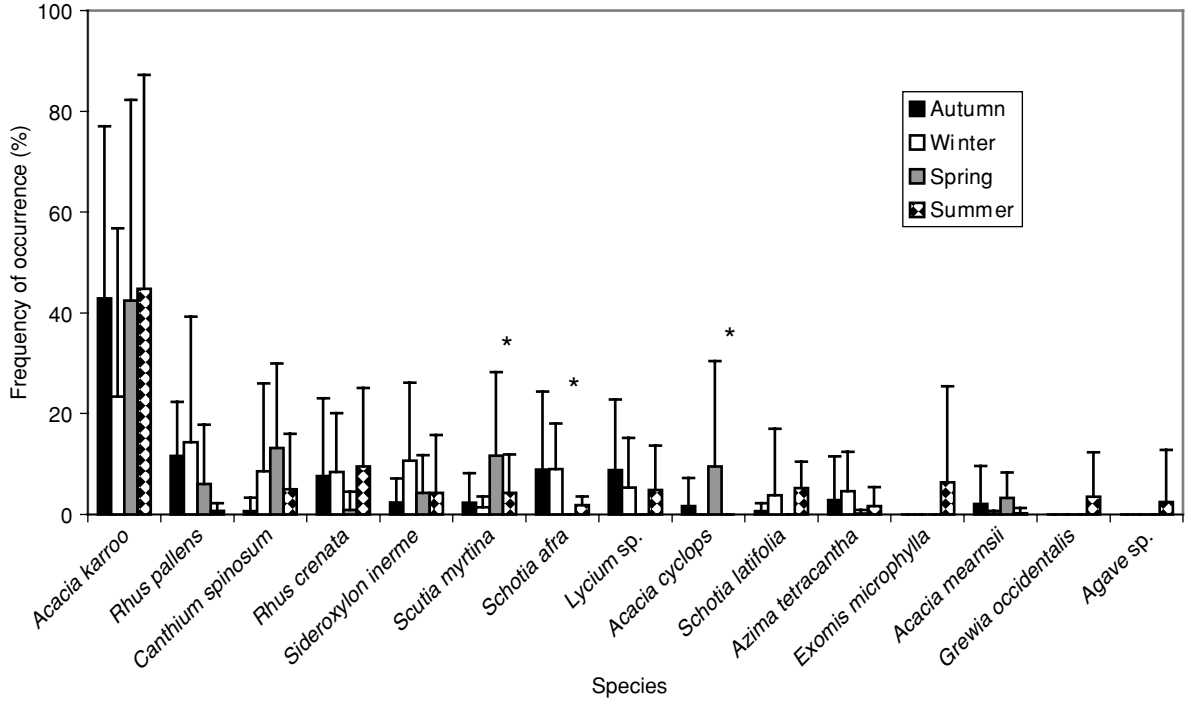


**Fig. 3.** The most important species in the diet of giraffe *Giraffa camelopardalis* at Kariega. The mean values ± 1 SD for each season are shown. $*P < 0.05$ between seasons for a species (Kruskal–Wallis ANOVA).

two or three species, the most important of which was *Acacia karroo*.

Innis (1958), Oates (1970), Leuthold & Leuthold (1972), Hall-Martin (1974), Stephens (1975), van Aarde & Skinner (1975), Field & Ross (1976) and Kok & Opperman (1980) all found leguminous plant species such as members of the genus *Acacia* to be the most prevalent in the diet of giraffe. The results from this study indicate a similar trend with most of the important species belonging to the thorn-tree (Mimosaceae) family, which is leguminous. The reason for this preference is the high protein and water content of the leaves (Hall-Martin & Basson, 1975; Sauer, 1983; Cooper, Owen-Smith & Bryant, 1988). The level of condensed tannin in the leaves is also important. Although members of the genus *Acacia* usually have high levels of condensed tannin, which inhibits digestion (Cooper & Owen-Smith, 1985), giraffe are capable of inducing increased shoot growth on some *Acacia* species through their browsing action (du Toit, Bryant & Frisby, 1990). These new shoots are high in protein and low in condensed tannin (du Toit *et al*., 1990). Thus, by creating a positive feedback between shoot growth and leaf chemistry, giraffe are capable of increasing the difference between protein and condensed tannin, thereby making them highly palatable. The proportion of grass in the diet of giraffe is typically low (Oates, 1970; Leuthold & Leuthold, 1972; Hall-Martin, 1974; Stephens, 1975; van Aarde & Skinner, 1975; Field & Ross, 1976; Sauer, Theron *et al*., 1977; Pellew, 1984*a*,*b*). The results from this study conform to this, with relatively little grass being consumed.

At Shamwari and Kwandwe, in all seasons, *Acacia karroo* and *Rhus longispina* were the two most important species in the diet of the giraffe. At Kariega *A. karroo* and two other *Rhus* species (*R. crenata* and *R. pallens*) were the most important species in the diet. At all three sites, *Acacia karroo* was less important in the diet during the winter when more *R. longispina* (*R. crenata* and *R. pallens* in the case of Kariega) was consumed. This dietary switch is attributed to the deciduous nature of *A. karroo*, which loses its leaves in the winter, at which time members of the genus *Rhus* become more important (Parker *et al*., 2003). Giraffe prefer new and growing shoots when they are available owing to their increased succulence or water content, and higher protein content (Hall-Martin & Basson, 1975; Sauer, 1983; Cooper *et al*., 1988). Such a preference could explain the seasonal variation of the other tree species at the three sites. For example, *Scutia myrtina* at Kariega became significantly more important in the spring when the trees produced new leaves. An alternative explanation for the seasonal variation could be the result of flowering or fruiting of the trees, as giraffe are known to consume both (Hall-Martin, 1974; van Aarde & Skinner, 1975; du Toit, 1990). This was certainly the case with *Pappea capensis* at Kwandwe where the giraffe were observed consuming both the leaves and the fruit in the summer months.

Previous studies on giraffe diet (within their native range) indicate that deciduous species such as *Acacia* dominate the vegetation of the habitats used by giraffe, and make up the bulk of the diet during the wet season (October–March). During the dry season (April–September), however, these deciduous species lose their leaves and the giraffe tend to concentrate along watercourses where they subsist on the only remaining, less preferred/less palatable semi-deciduous or evergreen

species (Hall-Martin, 1974; Hall-Martin & Basson, 1975; van Aarde & Skinner, 1975; Sauer, Theron *et al*., 1977; Sauer, Skinner *et al*., 1982; Sauer, 1983; Owen-Smith, 1992). The dry season is thus a nutritionally limiting period for giraffe and other browsers owing to reduced food availability and increased distances between feeding sites (Hall-Martin & Basson, 1975; van der Waal, Smit & Grant, 2003). During this period giraffe are often in poor condition, and increased mortality owing to malnutrition and predation is common (Hall-Martin & Basson, 1975). The results from this study indicate preference for deciduous species (*Acacia karroo*) during the summer (analogous to the wet season) and an increase in the importance of evergreen species (e.g. *Rhus longispina*) during the winter (dry season). Significantly, though, unlike giraffe within their native range, the majority of species consumed (in terms of numbers) in the Eastern Cape Province were evergreen. This is probably because of the reduced number of deciduous species in the province forcing the giraffe to adapt to a new (evergreen) food source, which is available all year round. There is no evidence of giraffe death due to malnutrition in the Eastern Cape Province, however, suggesting that the available evergreen browse is of sufficient quality and quantity for giraffe during the winter. Certainly, the valley thicket, which dominates the vegetation of the Eastern Cape Province, has an inherently high carrying capacity for browsers (Stuart-Hill, 1990).

Owen-Smith (1992) suggests that the impact of giraffe on tree populations in Africa is comparably less detrimental than the impact of other megaherbivores such as elephant *Loxodonta africana*, Blumenbach because they do not cause widespread damage to mature trees (e.g. uprooting and gap creation in forest). Only at high densities can giraffe suppress the growth of regenerating trees, which retards the recruitment of mature trees (Ruess & Halter, 1990; Birkett, 2002). Bond & Loffell (2001), however, have shown that giraffe introduced to an area beyond their native range are capable of causing tree mortality as a direct result of their browsing. Although it may be debatable as to whether giraffe impact is more or less detrimental to the vegetation of the Eastern Cape Province than domestic livestock, which are also non-native species (Stuart-Hill, 1992; Moolman & Cowling, 1994), many of the plant species have slow growth rates and have evolved in the absence of a 'top–down' browser (valley thicket generally being lower than 3 m) such as the giraffe (Aucamp & Tainton, 1984; Moolman & Cowling, 1994).

The results from the present study provide a comprehensive list of plant species that should be the focus of future research into giraffe impact in the Eastern Cape Province.

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