



## Diet selection in captivity by a generalist herbivorous rodent (*Octodon degus*) from the Chilean coastal desert

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Five captive adult female degus (*Octodon degus*) were offered leaves and twigs to eat from three woody (*Adesmia bedwellii*, *Porlieria chilensis* and *Proustia pungens*) and two suffruticose (*Baccharis paniculata* and *Chenopodium petiolase*) shrubs that provide cover in their natural habitat. The degus discriminated among the plant species, consuming lower amounts of *P. chilensis*. Daily body mass losses of degus were significantly higher when they were fed upon *P. pungens* and *P. chilensis*. The nutritional value of plants, concomitant with degu nutritional requirements, may explain changes in shrub cover previously found to follow removal of degus from experimental plots.

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### Introduction

Plant communities are known to be affected by foraging behaviour of small mammals (Davidson *et al.*, 1985; Palo & Robbins, 1991; Meserve *et al.*, 1993). The protein to fibre ratio of plants may determine food preferences of mammalian herbivores (Milton, 1979), so that foraging has a differential impact on the structure of plant communities. Herbivorous rodents such as *Neotoma* and *Octodon degus* Mol, for example, behaviourally reduce the fibre content of their diet (Justice & Smith, 1992; Bozinovic, 1995). In a Chilean coastal desert (Parque Nacional Fray Jorge), the cover response of shrubs and ephemeral plants to experimental removal of the principal herbivorous rodent (*O. degus*, the degu) for a 6-year period (1989–1994) was described by Gutiérrez *et al.* (1997). Although diversity and species composition of plant communities at the study site are known to be largely regulated by rainfall, removal of degus had significant effects on shrubs and ephemerals. For example, we found that the shrubs *Adesmia bedwellii*, *Baccharis paniculata* and *Chenopodium petiolare* increased their cover after removal of degus. In contrast, cover of the dominant thorn shrubs,

*Porlieria chilensis* and *Proustia pungens*, was not affected by degu removal (Gutiérrez *et al.*, 1997).

Foraging preferences by degus for suffruticose over woody shrubs may be related to trade-offs between food quality (availability of nitrogen, energy, water, fibre and perhaps secondary metabolites), intake and the efficiency of digestion, as suggested by Veloso & Bozinovic (1993) and Bozinovic (1995). Here we investigate whether the responses of the two different groups of shrubs (degu responsive *vs.* degu non-responsive) are a consequence of selective herbivory. Preference trials were conducted offering leaves and twigs of these five shrub species to captive degus. Then, feeding trials were conducted to test for changes in body mass of degus during intake of such diets.

### Methods

During October 1994 (spring season), seven adult female degus were captured with Sherman live traps near to the Parque Nacional Fray Jorge (71° 40' W, 30° 38' S) where a long-term study of plant cover responses to experimental removal of degus is currently being made (Gutiérrez *et al.*, 1997). Shortly after capture two degus died, so only five degus were used in the experiments. These had a mean body mass ( $m_b$ ) of  $113 \pm 14.5$  g (1 S.D.). The plant community is dominated by the woody thorn shrubs *Porlieria chilensis*, *Adesmia bedwellii* and *Proustia pungens*, and the suffruticose shrubs *Baccharis paniculata* and *Chenopodium petiolare* (Muñoz & Pisano, 1947; Gutiérrez *et al.*, 1993). The climate is semi-arid Mediterranean, with 90% of the 85 mm annual precipitation falling during winter (May–September). Animals were transported to the laboratory where the experiments were conducted. Leaves and twigs of *A. bedwellii*, *B. paniculata*, *Ch. petiolare*, *P. chilensis* and *P. pungens* were collected in the same site as the degus were captured.

### Plant analyses

Plant material was stored at 5°C until the experiments were run. The energy content and chemical composition of each species was determined (Table 1). Diets were analysed for neutral detergent fibre (see Bjorndal & Bolten, 1993). Nitrogen content was determined by the microKjeldahl method. Water was determined by drying plants to constant weight, and organic matter and ash by burning them at 500°C for 3 h.

**Table 1.** Proximate composition of plants offered to Octodon degus ( $g\ kg^{-1}$  dry matter)

	<i>Adesmia bedwellii</i>	<i>Baccharis paniculata</i>	<i>Chenopodium petiolare</i>	<i>Porlieria chilensis</i>	<i>Proustia pungens</i>
Ash	148	119	194	101	75
Organic matter	852	881	806	899	925
Water	370	540	595	280	330
Nitrogen	16	27	15	15	12
Neutral detergent fibre	468	369	615	273	508
Energy ( $kJ\ g^{-1}$ )	$19.5 \pm 0.03$	$21.9 \pm 0.03$	$20.2 \pm 0.05$	$22.6 \pm 0.04$	$21.6 \pm 0.04$

*Diet selection by Octodon degus*

Degus were maintained for 10 days in an outdoor laboratory during October 1994, with natural photoperiod (light:dark = 10h:14h) and ambient temperature (15–25°C), in two large enclosures (120 cm × 70 cm × 90 cm), with water and commercial pelleted rabbit food provided *ad libitum*, before the preference and feeding trials were made.

*Preference trials*

Preference trials of 1 day were made outdoors separately on each of the five animals, in an enclosure (110 cm × 60 cm × 80 cm high) with water *ad libitum*. Degus, deprived of food for the previous 8 h, were offered 30 g of entire twigs and leaves of each of the five plant species randomly placed in separate food containers. Ingestion was measured gravimetrically by drying and weighing of each plant species at the end of the 24 h. The number of replicates was five.

*Feeding trials*

During November 1994 five degus were kept indoors separately in metabolic cages of 25 cm × 20 cm × 20 cm, with metal trays underneath to collect faeces. Water was provided *ad libitum*, photoperiod was 12 h light:12 h dark, and ambient temperature was controlled at approximately 20°C (Nagy & Negus, 1993). Feeding trials were conducted by offering one plant species at a time *ad libitum* for 5 days, and measuring food ingestion and body mass daily. The value for the body mass of each degu is the average for the last 3 days. Each day food and faeces samples were weighed, dried at 60°C to constant weight, and stored. Energy content was determined in a Parr 1261 computerized calorimeter. Two replicates expressed as  $\text{kJ g}^{-1}$  organic matter were considered reliable when the difference between the two was less than 1% (Kleiber, 1975). Animals were allowed to rest between feeding trials. The number of replicates was five.

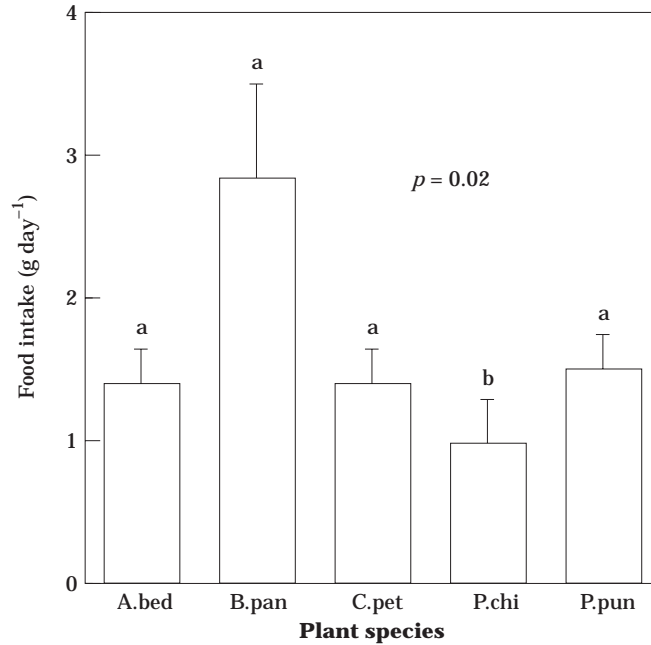
The significance of the effect of plant species on food electivity and nutritional variables was assessed by a one-way ANOVA, and a Kruskal-Wallis analysis of variance. Also the *a posteriori* Tukey and the non-parametric #C tests for multiple comparisons between groups were used (Steel & Torrie, 1985). Results are given as mean ± 1 S.D.

**Results***Preference trials*

When animals were allowed to choose between diets, they exhibited significant differences in food intake ( $F = 3.648$ ,  $p < 0.05$ ), given by a lower consumption of *P. chilensis* (Fig. 1). No significant difference in preferences was found between the other four species of plants.

*Feeding trials*

Although  $m_b$  did not differ significantly between individuals at the beginning of the experimental trials, percentage loss in  $m_b$  did. Daily  $m_b$  losses were significantly higher



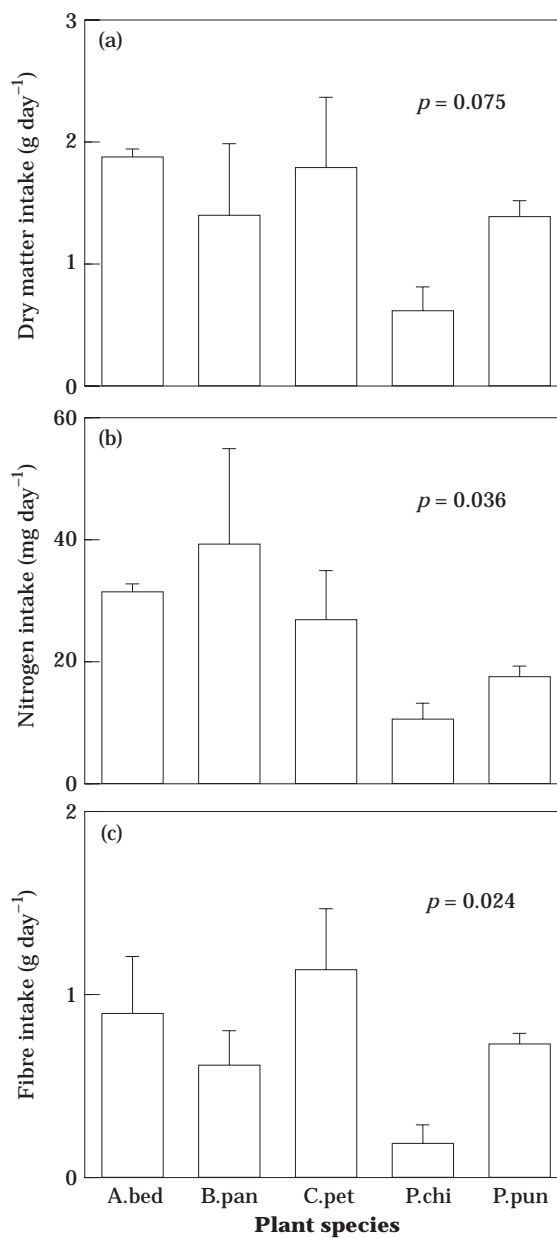
**Figure 1.** Food preferences by *Octodon degus* measured by food intake (g DM day<sup>-1</sup>). Experiments were conducted by offering the five different plant species for 24 h. The probability value after a one-way ANOVA test is indicated. Similar letters indicate non-significant differences between diets. A.bed = *Adesmia bedwellii*; B.pan = *Baccharis paniculata*; C.pet = *Chenopodium petiolare*; P.chi = *Porlieria chilensis*; P.pun = *Proustia pungens*.

( $H = 18.1$ ,  $p < 0.001$ ) in degus feeding on *P. pungens* and *P. chilensis* than for those ingesting *Ch. petiolare*. The effect of the other two species (*A. bedwellii* and *B. paniculata*) on  $m_b$  change did not differ significantly from the effect of *Ch. petiolare* (Table 2).

Although differences in dry matter ingestion rates of degus fed on each of the five shrub species were marginally not significant ( $H = 8.5$ ,  $p = 0.075$ ; Fig. 2(a)), ingestion of *P. chilensis* showed the lowest value. The rate of nitrogen ingestion was

**Table 2.** Daily body mass ( $m_b$ ) change of *Octodon degus* maintained on five shrub species. Each plant species was offered, one at a time, for 5 days

Plant species	Daily $m_b$ change (g day <sup>-1</sup> )	
	Mean	S.D.
<i>Adesmia bedwellii</i>	-6.3	1.7
<i>Baccharis paniculata</i>	-6.1	1.0
<i>Chenopodium petiolare</i>	-2.7	1.7
<i>Porlieria chilensis</i>	-11.5	0.7
<i>Proustia pungens</i>	-15.0	1.2



**Figure 2.** (a) Dry matter intake, (b) nitrogen intake and (c) fibre intake by *Octodon degus* maintained on five species of plants. Each plant species was offered, one at a time, for 5 days. Probability values after the Kruskal-Wallis test are indicated. A.bed = *Adesmia bedwellii*; B.pan = *Baccharis paniculata*; C.pet = *Chenopodium petiolare*; P.chi = *Porlieria chilensis*; P.pun = *Proustia pungens*.

significantly lower when degus fed on *P. chilensis* and *P. pungens* (Kruskal-Wallis = 10.2,  $p < 0.05$ ; Fig. 2(b)). Similarly, the fibre ingestion rate of degus fed on *P. chilensis* was lowest (Kruskal-Wallis = 11.2,  $p = 0.025$ ; Fig. 2(c)).

### Discussion

Complex polysaccharides (fibre) as well as secondary metabolites are important plant defensive constituents that often reduce food preferences in vertebrate herbivores (Howe & Westley, 1987), while nitrogen content positively affects food preferences. The successful transformation of plant energy into animal production and maintenance depends largely on food selection, intake, the concentration of indigestible material in the plant eaten and its nutritional value. However, since some plants and different parts of the same plant are easier to digest than others, the best foraging strategy for a small herbivore is to select foods that can be easily digested. For example, when degus are experimentally exposed to young and mature leaves of different species of the Chilean matorral shrubs (e.g. *Colliguaya odorifera*, *Kageneckia oblonga* and *Quillaja saponaria*), they prefer young over mature leaves, and do not discriminate between different shrub species (Simonetti & Montenegro, 1981), because mature leaves have a higher fibre content than young leaves.

In this study we found that degus minimized fibre ingestion and showed pronounced preferences for low fibre-high nitrogen food. In fact, *P. pungens* contained the least nitrogen and water and the second highest fibre content (Table 1), and was one of the less ingested plants. The rate of ingestion and body mass maintenance was significantly different between plants. Thus, degus apparently discriminate among plant species and reject *P. chilensis* as a dietary item. In fact, although degus are permanent residents under *P. chilensis* canopy they only occasionally (dry season) consume their leaves or seeds (Meserve, 1981).

As mentioned above, degu removal from the experimental plots in Parque Nacional Fray Jorge has significant effects on shrubs, and led to increased cover of some suffruticose shrubs such as *B. paniculata* and *Ch. petiolare*, but not of woody shrubs such as *P. chilensis* and *P. pungens* (Gutiérrez *et al.*, 1997). These effects may be a consequence of a process of selective foraging by degus on plant species with higher nutritional value. Preferences for suffruticose over woody shrubs would be related to the observed plants availability of nitrogen, energy, water and fibre. Ingestion rates were higher in the degu-responsive species than in the degu non-responsive species. For example, *Ch. petiolare* benefits from degu removal in the field, which is explained by the fact that this species represents up to 60% of the diet of the degu in some seasons (Meserve, 1981).

Depending on the year and season in Parque Nacional Fray Jorge, cover of *A. bedwellii* is between 3.5 and 6%, *B. paniculata* less than 2%, *Ch. petiolare* 10–20%, *P. chilensis* 23–35% and *P. pungens* 3–10% (Gutiérrez *et al.*, 1993). Therefore, *O. degus* does not necessarily feed on the most abundant species, giving more support to the idea that degus are able to select sparsely distributed plants of high quality in their habitats.

Finally, the quality of the majority of the vegetation available is too low to give small endotherm herbivores a positive energy or nutrient balance. These diets probably do not provide enough energy and nutrients for productive events, including reproduction. In this semi-arid ecosystem, small herbivorous mammals are highly dependent on selecting good quality plants or plant parts, leaving untouched a large portion of the vegetation. These small herbivores thus live in a "green desert" *sensu* Moen *et al.* (1993). In fact, Gutiérrez *et al.* (1997) 6 years after degu removal observed no significant effect on overall perennial cover at the semi-arid Parque Nacional Fray Jorge.

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