SHORT COMMUNICATION

Brushtail possum (*Trichosurus vulpecula*) diet in a north Westland mixed-beech (*Nothofagus*) forest

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Abstract: We quantified brushtail possum (*Trichosurus vulpecula*) diet in a mixed *Nothofagus fusca-N. menziesii* forest in north Westland. Diet comprised 49 food items of which four (*Aristotelia serrata, Muehlenbeckia australis* and *Weinmannia racemosa* foliage, and *W. racemosa* flowers) contributed 68%. The canopy dominant *Nothofagus* species were a minor diet component (<1%), while wood, fungi and bark were a small but consistent part of diet (10.1%). Our results are similar to previous possum diet studies in *Nothofagus* forests and suggest that possums are very selective in their feeding, both spatially and temporally, focusing on key preferred species in particular parts of the forest and taking advantage of different food types that become available at different times of the year.

Keywords: beech forest; brushtail possum; herbivores; invasive species; New Zealand.

Introduction

Australian brushtail possums (*Trichosurus vulpecula*) are a serious conservation and production pest in New Zealand (Department of Conservation, 1994; Montague, 2000). Possum range has expanded since their introduction in the mid-1850s through a process of natural dispersal and internal liberation and they now occur throughout most of New Zealand. While possums are primarily herbivorous, an increasing number of studies have emphasised they are omnivores, feeding on fungi, invertebrates and vertebrates, as well as plant material (Nugent *et al*., 2000).

Most possum research in indigenous forest has focused on vascular plant species rich non-*Nothofagus* broadleaved and mixed conifer-broadleaved forests (Nugent *et al*., 2000). In contrast, less is known about possum diet in vascular plant species poor *Nothofagus* forests, despite these accounting for nearly 40% of New Zealand's remaining indigenous forests (Newsome, 1987). This is because the canopy dominants (*Nothofagus* species) are not considered preferred browse species for possums (James, 1974) and possum browse does not result in large-scale canopy dieback (cf. *Metrosideros-Weinmannia* or *Fuchsia* forest; Rose *et al*., 1993). As a result *Nothofagus* forests tend to be a lower priority for possum control (Department of Conservation, 1994). However, several studies have shown that possums can have important impacts on a range of indigenous biodiversity values in *Nothofagus* forests (Owen and Norton, 1995; Pekelharing *et al*., 1998).

As a contribution towards better understanding the diet of brushtail possums in New Zealand *Nothofagus* forests we present data on possum diet in a mixed *Nothofagus fusca-Nothofagus menziesii* forest in north Westland. We also discuss the distribution of possum-preferred food types within the forest.

Methods

The study was undertaken in a *c.* 100 ha area of mixed *Nothofagus fusca-Nothofagus menziesii* forest at

Palmers Road on the west coast of New Zealand's South Island (42°26' S, 172°05' E; Ella Ecological District). The Palmers Road site (450 m a.s.l) is located on a gently sloping (1-10°) river terrace with a north-west aspect and is directly adjacent to the Upper Grey River.

Vegetation data were collected using 30 "recce" vegetation plots (*c.* 400m^2; Allen, 1992) randomly located along three transects within the three vegetation types present: (1) the predominant *Nothofagus fusca-Nothofagus menziesii* terrace forest (> 90% of the area: 18 plots); (2) *Nothofagus fusca-Weinmannia racemosa* gully forest (< 5%: 6 plots); (3) roadside *Aristotelia serrata* shrubland (< 5%: 6 plots). Plant cover-abundance was recorded for all plant species present in four strata; canopy (10-20 m), sub-canopy (3.5-10 m), shrub (0.5-3.5 m), and ground (< 0.5 m) using seven cover classes: < 1, 1-5, 6-10, 11-25, 26-50, 51-75, and 76-100%.

Possum stomachs were collected from the *Nothofagus fusca-Nothofagus menziesii* terrace forest at five times between January 1998 and May 1999 in the same area where the vegetation plots were located. Possums were killed using cyanide paste or encapsulated cyanide pellets (Feratox®, Feral Control, Wellington) located at *c.* 50 m intervals along transects through the forest. A total of 95 usable stomachs (with distinct layers) were collected: 15 in January 1998, 10 in June 1998, 25 in November 1998, 24 in February 1999 and 21 in May 1999. Samples were analysed using the method of Sweetapple and Nugent (1998) as stomach contents were observed to be layered. Layers were generally homogeneous, although in a few stomachs items uncommon in the diet occurred as lenses within otherwise distinct layers. Individual food items were identified, weighed, oven-dried at 80°C for 48 hours, then reweighed. Dry weights of individual food items were then converted to percentage contribution to total diet. The number of food items per stomach was compared between male and female possums and between different sample periods using analysis of variance performed using PROC GLM in SAS.

Results

Seventy-eight plant taxa were recorded at the Palmers Road site. Four taxa (*Nothofagus fusca*, *N. menziesii*, *Aristotelia serrata*, and *Weinmannia racemosa*) contributed the major cover within at least one of the three vegetation types. Terrace forest plots were dominated by *N. fusca* and *N. menziesii*, although the fern *Blechnum discolor* was dominant in the ground layer. *Nothofagus fusca* and *W. racemosa* dominated the canopy and sub-canopy of the gully forest plots, while *B. discolor* was again an important constituent of the ground layer. In the roadside shrubland *A. serrata* was dominant, while *N. fusca* and *Fuchsia excorticata* were of less importance.

Possums consumed a total of 49 different food types in their diet (Table 1). The average number of food items per stomach was 4.9 ± 0.2 (± 1 SE) for the entire study period, with no significant difference between males and females (4.8 ± 0.3 cf. 5.1 ± 0.3; $F = 0.51$, $P = 0.476$). However, there were significantly fewer food items per stomach in January 1998 (3.7 ± 0.4) and November 1998 (3.8 ± 0.3), than in June 1998 (5.8 ± 0.6), February 1999 (6.1 ± 0.3) or May 1999 (5.4 ± 0.4; $F = 8.84$, $P = < 0.001$).

Twelve principal food types, defined as those that occurred in ≥ 10% of stomachs and contributed ≥ 1% of overall dry weight, contributed 93.7% of overall diet. Four food types (*Aristotelia serrata*, *Muehlenbeckia australis* and *Weinmannia racemosa* foliage, and *W. racemosa* flowers) contributed more than 10% each to overall diet, although each of these food types showed considerable variation between sample times (Table 1). *Weinmannia racemosa* foliage ranged from 0.3% of diet in January 1998 to 46.1% in June 1998, while flowers were only recorded on two occasions, comprising 35.7% of diet in January 1998 and 9% in November 1998. *Aristotelia serrata* foliage varied between 2.6% of diet in June 1998 and 33.6% in February 1999, while *Muehlenbeckia australis* foliage varied between 2.9% in January 1998 to 27.8% in February 1999.

Other food types, both foliage and non-foliage, also showed considerable variation in importance in possum diet between sample periods. Foliage of *Fuchsia excorticata* and *Pseudopanax* spp. were important in diet at some times (highs of 7.9% and 16% respectively) but were absent at other times. Wood and fungi ranged from highs of 10.5% and 10% of diet respectively, to complete absences. Unidentified seeds and Coleopteran larvae, although minor diet components in terms of dry weight, were consistently present in stomachs at particular times (e.g. 54% of stomachs in February 1999 and 48% of stomachs in May 1999 respectively) and absent at others. The most common non-native food type recorded was foliage of the introduced herb *Trifolium repens* which contributed 6.9% of overall diet and was found in all samples (ranging from < 1% to 12.8% dry weight).

Discussion

The foliage of *Nothofagus fusca* and *N. menziesii*, the canopy dominants, is unimportant in possum diet (0.6% and < 0.1% respectively, Table 1), a similar result to that found in south Westland and Southland

Table 1. Mean percentage dry weight (%DW) of food types (foliage unless otherwise stated) and their frequency in stomachs (%N) for five sample times. Number of stomachs analysed: Jan 98, 15; Jun 98, 10; Nov 98, 25; Feb 99, 24; May 99, 21. t indicates a trace amount.

	Jan-98		Jun-98		Nov-98		Feb-99		May-99		Overall
Food types	%DW	%N	%DW	%N	%DW	%N	%DW	%N	%DW	%N	%DW
Aristotelia serrata	18.2	40	2.6	30	30.8	32	33.6	75	22.0	52	23.5
Muehlenbeckia australis	2.9	7	21.1	60	26.8	60	27.8	46	8.0	33	17.1
Weinmannia racemosa	0.3	7	46.1	40	7.3	28	5.5	29	44.9	62	16.8
Weinmannia racemosa (fl)	35.7	60	0.0		9.0	16	-		-		10.7
Trifolium repens	7.9	53	t	10	12.8	36	t	13	11.0	14	6.9
Wood	-		2.5	30	0.6	20	10.5	54	10.2	52	4.7
Fungi	2.0	27	0.3	50	-		10.0	29	3.0	71	3.3
Fuchsia excorticata	7.9	33	-		-		5.0	54	-		3.0
Pseudopanax spp.[1]	-		16.0	50	1.4	16	-		0.1	14	2.2
Bark	0.2	27	3.9	10	3.5	12	3.3	33	0.1	14	2.1
Blechnum discolor	4.5	27	0.2	20	3.0	28	t	17	-		1.8
Coprosma rotundifolia	3.8	33	0.6	20	2.6	8	-		0.3	14	1.6
Lycopodium fastigiatum	4.7	27	-		-		-		-		1.1
Nothofagus fusca	2.6	13	-		t	8	-		-		0.6
Rubus sp.	-		0.8	20	-		2.2	13	t	10	0.6
Urtica incisa	1.9	7	-		-		-		-		0.5
Schefflera digitata	1.9	13	-		-		-		-		0.5
Nertera villosa [2]	0.6	13	t	10	1.2	4	0.2	17	t	14	0.5
Nertera villosa (fl)	1.8	7	-		-		-		-		0.4
Coprosma foetidissima	t	7	2.6	50	-		-		-		0.3
Rubus sp. (fruit)	-		2.4	20	-		-		t	10	0.3
Cirsium sp.	-		-		-		1.2	8	-		0.3
Metrosideros sp.	0.8	7	-		-		-		-		0.2
Hieracium sp.	-		-		0.8	4	-		-		0.2
Fern	0.6	7	-		t	4	t	8	-		0.1
Polystichum vestitum	0.3	13	0.3	10	-		-		t	14	0.1
Aristotelia serrata (fruit)	0.1	7	-		-		0.4	17	-		0.1
Coleopteran larvae	-		0.6	50	t	8	t	21	t	48	0.1
Petiole wood	-		0.1	20	-		t	33	0.4	19	0.1
Blechnum minus	0.3	13	-		-		-		-		0.1
Lotus pedunculata	0.3	13	-		-		-		-		0.1
Taraxacum sp.	0.2	13	-		t	4	-		-		0.1
Blechnum chambersii	0.2	7	-		-		-		-		0.1
Nothofagus menziesii	-		t	10	0.1	12	-		t	10	t
Acari (mite)	-		t	10	-		-		-		t
Arachnid	-		-		-		t	8	-		t
Blue/green algae	-		-		t	16	-		-		t
Cardamine spp.	-		-		t	8	-		-		t
Coprosma spp.	-		-		t	16	t	8	t	14	t
Lastreopteris glabella	t	7	-		-		-		-		t
Moss	t	7	-		-		-		-		t
Neomyrtus pedunculata	t	13	-		-		-		-		t
Nothofagus sp.	t	7	-		-		-		-		t
Orthoptera	-		-		-		t	21	t	14	t
Parsonsia sp.	t	13	-		-		-		-		t
Poaceae	-		t	30	-		t	21	-		t
Seed	-		-		-		t	54	t	29	t
Ulex europaeus	t	7	-		-		-		-		t
Unidentified hair	-		-		t	8	t	17	-		t

[1] includes *Raukaua* species
[2] B.H. Macmill. Et R. Mason

N. menziesii forests (Owen and Norton, 1995; Nugent *et al*., 2000; H. Cochrane and D. Norton, *unpubl*.). However, in north Canterbury mixed-*Nothofagus* forests, *Nothofagus* foliage comprised 11.9% of total diet (P. Sweetapple, Landcare Research, Lincoln, New Zealand, *pers. comm.*). The dominant foliage diet components at Palmers Road were the angiosperm trees *Aristotelia serrata* and *Weinmannia racemosa*, and the liane *Muehlenbeckia australis* (Table 1), collectively comprising 57.4% of possum diet. These species were also dominant in possum diet in south Westland *Nothofagus menziesii* forests, comprising 32-58% of total diet in four diet studies (Owen and Norton, 1995; Nugent *et al*., 2000). Other common foliage food types at Palmers Road (e.g. *Fuchsia excorticata* and *Pseudopanax* (including *Raukaua*) species) were also important in these south Westland studies.

Several non-foliage food items were also found to be important at Palmers Road. *Weinmannia racemosa* flowers accounted for 10.7% of overall diet, while wood, fungi and bark were also important (10.1% of diet). In south Westland, invertebrate larvae and fruit were important in diet (7.6 and 2.5%; Owen and Norton, 1995), while in Southland, fungi and fruit were important (32.1 and 9.9%; (H. Cochrane and D. Norton, *unpubl.*). In north Canterbury *Nothofagus* forest, the most common non-foliage food types were fungi and *Nothofagus* seed (29.3% and 27.2% of diet respectively; P. Sweetapple, *pers. comm.*). The high component of *Nothofagus* seed reflected the occurrence of a heavy mast event at the time the possums were sampled.

A distinctive feature of possum diet at Palmers Road is the high variability in food type used at different sample times. For example, *Aristotelia serrata*, the most common food type in possum diet at Palmers Road (23.5%), ranged from a low of 2.6% diet in June 1998 to a high of 33.6% diet in February 1999. Similar variation can be seen in other foliage food types (e.g. *Muehlenbeckia australis* 2.9-27.8% and *Weinmannia racemosa* 0.3-46.1%) and is also apparent in non-foliage food types. For example, *Weinmannia racemosa* flowers were the single most important food type in January 1998 (35.7%) but were not present in diet in June 1998, February 1999 and May 1999. Fungi also varied from 0-10% diet. Similar seasonal diet variability has been observed in other *Nothofagus* forests (Owen and Norton, 1995; Pekelharing *et al*., 1998) and in other forest types (Nugent *et al*., 2000) reflecting the ability of possums to broadly track the seasonal cycle of availability (e.g. flowering) of key food resources.

While the dominant vegetation type in the Palmers Road study area is *Nothofagus* terrace forest, two of the four most dominant foods found in possum diet (*Aristsotelia serrata* and *Muehlenbeckia australis* foliage) are seral species from gully and roadside sites that are either absent or very uncommon in the terrace forest (Table 2). The other dominant species in possum diet (*Weinmannia racemosa* foliage and flowers) does have a low occurrence in the terrace forest but is most common in the gully forests. Although possums are resident within the terrace forest (which is where they were killed), it is clear they are targeting food resources within the spatially restricted gully forest and roadside shrubland areas, which is where these food types are most common.

These comparisons confirm the results of other published and unpublished diet studies in *Nothofagus* forests (Owen and Norton, 1995; Pekelharing *et al*., 1998; Nugent *et al*., 2000; H. Cochrane and D. Norton, *unpubl.*; P. Sweetapple, *pers. comm.*) and suggest that possums are opportunistic omnivores in these forests, as they are in other forest types (cf. Nugent *et al*., 2000). While relying on a staple diet of foliage, possums are utilising a variety of other food resources as they become available. In addition, possums are clearly able to locate and utilise particular food resources within the broader ecosystem, even those that are spatially quite restricted in their distribution (e.g. roadside plants in our study). This suggests that further research needs to consider multiple spatial scales as well as temporal scales in better understanding the manner in which possums utilise food resources in these ecosystems.

Table 2. Percentage cover of plant species in the three vegetation types for those plants also recorded in possum diet at Palmers Road, and percentage foliage contribution to diet (as a proportion of all foliage consumed).

Taxa	Percentage cover			Diet
	Forest	Gully	Road	%
Aristotelia serrata	-	3.0	49.9	30.1
Muehlenbeckia australis	<0.1	-	2.0	21.9
Weinmannia racemosa	1.4	34.5	-	21.5
Fuchsia excorticata	<0.1	0.3	6.2	3.8
Pseudopanax spp.	1.0	1.5	2.0	2.8
Blechnum discolor	8.5	2.5	0.1	2.3
Coprosma rotundifolia	-	-	1.0	2.0
Rubus sp.	0.3	0.3	5.2	0.8
Nothofagus fusca	46.2	35.3	6.8	0.8
Nertera villosa	0.2	0.1	0.2	0.6
Schefflera digitata	-	0.6	4.2	0.6
Coprosma foetidissima	0.2	0.2	-	0.4
Blechnum chambersii	<0.1	<0.1	-	0.1
Polystichum vestitum	<0.1	<0.1	0.1	0.1
Neomyrtus pedunculata	5.0	-	-	0.1
Nothofagus menziesii	24.6	6.9	0.6	0.1

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